Illinois U Library
R
016.53
P578

SCIENCE ABSTRACTS: SECTION A 2600–3434

OLUME 59

PHYSICS ABSTRACTS

UMBER 700

PRIL 1956

Published by The Institution of Electrical Engineers

SECTION A OF SCIENCE ABSTRACTS *(Section B: Electrical Engineering)*

Edited and issued by THE INSTITUTION OF ELECTRICAL ENGINEERS, Savoy Place, London, W.C.2

In association with THE PHYSICAL SOCIETY, THE INSTITUTE OF PHYSICS, THE AMERICAN PHYSICAL SOCIETY, AND THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Co-operating member of the I.C.S.U. Abstracting Board (International Council of Scientific Unions)

Physics Abstracts

CONTENTS

MATHEMATICS	51	Molecular and atomic structure	539.1
ASTRONOMY. ASTROPHYSICS. GEODESY	52	Theory of solid state	539.11
PHYSICS	53	Molecules	539.13
Fundamentals	530.1	Atoms. Nucleus. Isotopes	539.15
General mechanics. Mechanics of solids	531	Radioactivity. α-, β- and γ-rays	539.16
Mechanical measurements	531.7	Nuclear reactions	539.17
Mechanics of fluids	532	Atom and molecular beams. Mesons. Neutrons	539.18
Capillarity	532.6	Structure of solids	539.2
Molecular theory of liquids	532.7	Elasticity. Strength. Rheology	539.3/.8
Mechanics of gases	533	PHYSICAL CHEMISTRY	541
Molecular theory of gases	533.7	Phase equilibrium. Chemical reactions	541.11/.12
Vibrations. Acoustics	534	Electrochemistry	541.13
Optics. Radiation. Spectra	535	Photochemistry. Radiation chemistry	541.14/.15
Heat	536	Dispersions. Colloids. Adsorption	541.18
Thermodynamics	536.7/.8	Chemical structure	541.2/.6
Electricity	537	Chemical analysis	543/545
Electrostatics. Dielectrics	537.2	CRYSTALLOGRAPHY	548
Electric conduction. Currents	537.3	Atomic and X-ray crystallography	548.7
Electric discharges	537.52	GEOPHYSICS	55
X-rays	537.531	Atmosphere. Meteorology	551.5
Cathode rays. Positive rays	537.533/.534	BIOLOGY	57/59
Discharge tubes. Counters	537.54	Medical science. Human physiology	61
Ionization. Thermionics	537.56/.58	TECHNIQUE. MATERIALS	62/69
Cosmic rays	537.591	Photography	77
Magnetism	538		
Electromagnetism. Electrodynamics	538.3/.5		
Electromagnetic waves and oscillators	538.56		

The number given for each subject is the Universal Decimal Classification number; the appropriate page can be found by referring to the U.D.C. numbers printed above each abstract on the right.

The monthly Author Index, List of Journals, Errata and Notes follow immediately after the last page of abstracts.

RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments	Waveguides	Amplifiers
Electronic relays and counters	Photocells	Electroacoustic apparatus
Automatic control mechanisms	Thermionic tubes	Radiocommunication
Applied electrochemistry	Cathode-ray tubes	Mechanical engineering
Lines and networks	X-ray tubes	Illumination
	Oscillators. Pulse circuits	

Committee of Management 1955–56

THE INSTITUTION OF ELECTRICAL ENGINEERS

THE PRESIDENT *(ex officio)*

S. WHITEHEAD, M.A., D.Sc., M.I.E.E. *(Chairman)*

L. G. BRAZIER, Ph.D., B.Sc., M.I.E.E.

L. HARTSHORN, D.Sc., M.I.E.E.

R. L. SMITH-ROSE, C.B.E., D.Sc., M.I.E.E.

THE PHYSICAL SOCIETY

R. C. EVANS, M.A., Ph.D., B.Sc.

A. G. GAYDON, D.Sc., F.R.S.

D. ROAF, M.A., D.Phil.

MISS A. C. STICKLAND, M.Sc., Ph.D.

THE INSTITUTE OF PHYSICS

E. R. DAVIES, O.B.E., F.Inst.P.

THE ROYAL SOCIETY

T. E. ALLIBONE, D.Sc., Ph.D., M.I.E.E., F.R.S.

THE CENTRAL ELECTRICITY AUTHORITY

L. W. JAMES, M.A., A.M.I.E.E.

Editorial

EDITOR

B. M. CROWTHER, M.A., Ph.D., F.Inst.P.

ASSISTANT EDITORS

G. N. J. BECK, B.Sc., A.M.I.E.E., A.Inst.P.

N. R. FOWLER, A.R.C.S., D.I.C., F.Inst.P.

R. R. O. SKELTON, B.A.

Annual Subscriptions

Section A, £4 10 0; Section B, £3 10 0; both sections, £7 10 0.

Printed on one side only, for mounting on cards (indexes on request only):

Section A, £5 10 0; Section B, £4 10 0; both sections, £9 10 0.

Copyright. All rights reserved.

PHYSICS ABSTRACTS

Volume 59 APRIL 1956 Number 700

MATHEMATICS 51

512.3

2600. A SHORT TABLE OF THE LAGUERRE POLYNOMIALS. L.J.Slater.
Proc. Instn Elect. Engrs, Monogr. No. 136, publ. June, 1955 (Vol. 103 C, 46-50).

Republication of the monograph abstracted in Abstr. 5161 (1955).

512.39 : 512.37

2601. AN APPROXIMATE SOLUTION OF AN ALGEBRAIC EQUATION OF HIGH DEGREE WITH NO REAL ROOT OR ONE. S.Hayashi and K.Uo.
J. Inst. Elect. Engrs Japan, Vol. 74, No. 11, 1375-81 (Nov., 1954). In Japanese.

While the Heaviside operational calculus is convenient for solving transient phenomena which are expressed by linear differential equations, it involves equations of high degree which are time consuming to solve. A more convenient method is described which is applicable when the real part of each complex root is small compared with the imaginary part. The squares of the imaginary parts of the complex roots are obtained from a subsidiary equation, whose terms are composed only of either odd-degree terms or of even-degree terms of the original equation, depending upon whether the latter is of odd or of even degree. Computation is easy since the subsidiary equation has real roots only and its degree is half that of the original equation. The real parts of the required complex roots are obtained by substituting the imaginary parts in the original equation. H.G.M.Spratt

517.5

2602. CONCERNING THE COMPLEX CONJUGATE OF A FUNCTION. S.Y.Tiwari and B.Bhattacharya.
Amer. J. Phys., Vol. 23, No. 9, 624 (Dec., 1955).

It is pointed out that the method used by some writers for obtaining the conjugate of a function, namely to change the sign of i in the function itself, is unsatisfactory for multiply-valued functions, and may lead to errors. Examples considered are $i^{1/2}$ and $i^{1/3}$. In such cases the rigorous definition of the conjugate must be used. L.S.Goddard

517.512.2

2603. GENERALIZED FOURIER INTEGRALS. K.S.Miller and L.A.Zadeh.
I.R.E. Trans Circuit Theory, Vol. CT-2, No. 3, 256-60 (Sept., 1955).

Classical Fourier analysis is based on the decomposition of time functions into pure sine waves or exponentials. In this paper, a more general method of decomposition involving periodic elementary time functions is developed. Explicit inversion formulae are obtained and a general expression for the inverse kernel is derived. In the special case of elementary signals having the form of square waves, it is found that the coefficients entering into the expression for the inverse kernel are given by a function which is closely related to the Mobius function. As an application, the impulsive response of an ideal filter which passes all square waves whose fundamental frequency is less than ω_0 and stops all those whose fundamental frequency is greater than ω_0, is determined. A.

517.512.2 : 621.317.757

2604. A SIMPLE ELECTRONIC FOURIER SYNTHESIZER. H.B.Mohanti and A.D.Booth.
J. sci. Instrum., Vol. 32, No. 11, 442-4 (Nov., 1955).

An attempt has been made to reduce the complexity of machines for two-dimensional Fourier synthesis by storing the accurately phased sine and cosine functions which are required on a magnetic drum. A small experimental model shows that the system is practicable and suggests improvements which might be incorporated into a complete machine. A.

518.5

2605. A MECHANICAL BINARY-DECIMAL CONVERTER. M. Setterwall.
J. sci. Instrum., Vol. 33, No. 1, 18-19 (Jan., 1956).

A simple and reliable mechanical device is described which is able to convert a number N from binary to decimal form. Details are given of a ten-digit convertor, capable of exact conversion of numbers up to 1023. By using this in two steps, numbers up to $2^{20} \simeq 10^6$ can be converted with a relative accuracy better than $1/\sqrt{N}$. A.

518.5 : 537.222 : 621.317.729

2606. A SIMPLE EQUIPMENT FOR SOLVING POTENTIAL AND OTHER FIELD PROBLEMS. C.T.Murray and D.L. Hollway.
J. sci. Instrum., Vol. 32, No. 12, 481-3 (Dec., 1955).

A method is described for the solution of two-dimensional field problems using, as an electrical analogue, current flow in a sheet of ordinary paper. As the paper resistivity is high, pencil lines are used as electrode boundaries. Details of the circuit and construction of a suitable equipment are given and considerations affecting accuracy are discussed. A.

518.5 : 681.142

2607. ELECTRONIC COMPUTING MACHINES AND THEIR USES. J.H.Wilkinson.
J. sci. Instrum., Vol. 32, No. 11, 409-15 (Nov., 1955).

The two main classes of computing machines, digital and analogue, are defined and a short history of digital machines is given. The basic principles of design of the electronic digital computers which followed ENIAC are described and the elements of programming for the new machines are indicated. The types of computation in physics and engineering for which the machines are suitable are outlined. A.

519.2

2608. CORRECTING FOR RUNNING MEANS BY SUCCESSIVE SUBSTITUTIONS. R.N.Bracewell.
Austral. J. Phys., Vol. 8, No. 3, 329-34 (Sept., 1955).

Discusses a practical procedure which compensates for the effect of taking running means, and a numerical example is worked out. The procedure simply requires the evaluation of further running means and should prove readily applicable in many cases where the need arises. In this procedure, which has already gained importance in more general form in other fields (as the method of successive substitutions), a criterion of convergence has been given; and it is a major aim of the paper to illustrate, using running means as an instance, that the utility of the method of successive substitutions is wider than is indicated by this criterion. The mathematical theory shows that the proposed procedure leads to a divergent result in the case of running means; nevertheless the asymptotic nature of the divergence allows results of practical value. An illumi-

nating view of the phenomenon is given from the standpoint of Fourier analysis, which reveals a counterplay of simultaneous deterioration and improvement occurring in different spectral regions. A.

519.2

2609. THE DISTRIBUTION OF THE RATIO OF TWO QUADRATIC FORMS. G.S.Watson.
Austral. J. Phys., Vol. 8, No. 3, 402-7 (Sept., 1955).

The exact probability distribution of the ratio of two quadratic forms is given in the case where the quadratic forms and the multivariate normal distribution of the variables is such that the ratio is a ratio of linear functions of gamma variables of integral order. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

523.161

2610. SOLID PARTICLES IN THE STARS.
Mem. Soc. Roy. Sci. Liège, Vol. 15, Special No., 687 pp. (1954).

For abstracts see Abstr. 1784-98, 1805-12, 1816, 1818-1822, 1953, 2014, 2038, 2569 (1956). For remaining papers see Abstr. 872 (1956).

523.164 : 523.165

2611. HALO OF RADIO EMISSION AND THE ORIGIN OF COSMIC RAYS. G.R.Burbidge.
Phys. Rev., Vol. 101, No. 2, 906-7 (Jan. 15, 1956).

Observed emission from Andromeda and from our own galaxy suggest an approximate spherical distribution of radio stars. The observations could be explained by assuming an appreciable distribution of diffuse matter and magnetic field normal to galactic planes, emission being synchrotron radiation emitted by relativistic electrons moving in random magnetic fields in the halo regions. R.A.Newing

523.164 : 538.56 : 537.591

2612. ON THE ORIGIN OF SUPERTHERMAL COSMIC RADIOFREQUENCY RADIATION. R.W.Larenz.
Z. Naturforsch., Vol. 10a, No. 12, 901-13 (1955). In German.

Equations set up for the propagation of longitudinal plasma waves of finite amplitude are used for a quantitative examination of the mechanism previously proposed (Abstr. 7629/1955) for the generation of radiofrequency radiation. R.A.Newing

523.164.4

2613. GALACTIC SURVEY AT 400 Mc/s BETWEEN DECLINATIONS -17° AND -49°. R.X.McGee, O.B.Slee and G.J.Stanley.
Austral. J. Phys., Vol. 8, No. 3, 347-67 (Sept., 1955).

The zone of the sky between declinations -17° and -49° was surveyed with a pencil-beam aerial. The operating frequency was 400 Mc/s and the aerial beam width 2° between half-power points. It is shown by means of contour diagrams of equivalent sky temperature that the central Milky Way consists of a narrow background of radiation (about 5° between half-power points) on which is superimposed a number of discrete radio sources. Test measurements at two points on the galactic plane indicate random polarization of the radiation. A most intense source in R.A. 17 hr 42 min, Dec. -28.5° (1950) is believed to represent radiation from the galactic nucleus. The radio-frequency spectra of the Milky Way sources and other observed in the course of the survey are shown to be divided into two classes, indicating two different mechanisms in the production of discrete source radiation. A.

523.164.4

2614. THE OBSERVATION AND INTERPRETATION OF RADIO EMISSION FROM SOME BRIGHT GALAXIES. B.Y.Mills.
Austral. J. Phys., Vol. 8, No. 3, 368-89 (Sept., 1955).

Preliminary attempts to observe 13 bright southern galaxies are described. Of these 10 were detected, including the Magellanic Clouds. The latter were studied in detail. Supplementary measurements on the Milky Way near the galactic centre were made and also some unsuccessful attempts to observe two globular clusters. Taking these results in conjunction with some observations of Brown and Hazard it is possible to derive a consistent picture of the radio emitting properties of "normal" galaxies. It is found that radio emission probably occurs with two markedly different distributions, one displaying characteristics of a type I population, the other having a very extensive, roughly spherical, spatial distribution quite unlike any known stellar population. Both distributions have a non-thermal spectrum, and the relative contributions of each appear to vary between different galaxy types. In general terms, although not altogether in detail, these results support the conclusions reached by Shklovskii concerning the distribution of radio emission in the Galaxy; also his interpretation of the spherical distribution as the result of relativistic electrons radiating in weak magnetic fields is examined, and found, with some modifications, to afford a plausible explanation of the observed differences between the radiating efficiencies of different types of galaxies. A.

523.164.85

2615. THE RADAR DETERMINATION OF METEOR SHOWERS IN THE SOUTHERN HEMISPHERE. C.D.Ellyett and K.W.Roth.
Austral. J. Phys., Vol. 8, No. 3, 390-401 (Sept., 1955).

During the greater part of 1953 a radar survey was made of meteor activity in the southern hemisphere. The results are presented, together with a brief description of the apparatus used. Radiants are calculated from daily range-time plots of meteor echoes, and the resulting showers are in accord with data reduced from earlier visual observations. Both radar and visual data for the southern hemisphere show many night radiants between mid June and mid August. Showers in this period are clearly defined but overlap in date, and there is a marked drift in the direction of the meteor activity as the date progresses. Two new southern hemisphere daylight showers of moderate strength have been found by radar in June and October respectively, and considerable confused night activity is present in early December. The greater proportion of both the northern and the southern hemisphere meteor shower radiants appear to lie close to the plane of the ecliptic. A.

523.164.85

2616. METEOR ECHO DURATIONS AND VISUAL MAGNITUDE P.M.Millman and D.W.R.McKinley.
Canad. J. Phys., Vol. 34, No. 1, 50-61 (Jan., 1956).

The statistical relation between the radio echo duration and the visual magnitude has been investigated for approximately 3300 meteors observed on the combined Dominion Observatory — National Research Council programme at Ottawa. Both echo durations and visual magnitudes were reduced to absolute values, defined as those for a meteor in the zenith at a height of 100 km. For meteors in the absolute magnitude range +5 to −5 a straight line relation exists between log absolute magnitude, longer durations corresponding to brighter meteors. Applying current

meteor theory to these data indicates that a meteor of absolute magnitude range +5 to −5 a straight line relation exists between log absolute duration and absolute magnitude, longer durations corresponding to brighter meteors. Applying current meteor theory to these data indicates that a meteor of absolute magnitude +5 produces 2×10^{12} electrons per cm of path length. For Perseid meteors the ratio between ionization produced and visual luminosity is almost constant in the range +5 to −5 absolute magnitude. For other meteors this ratio seems to decrease somewhat for the brighter objects. These results lead to higher electron densities for the bright meteors than had previously been estimated. A.

523.165 : 537.591.1

2617. ORIGIN OF COSMIC RADIATIONS. C.Y.Fan.
Phys. Rev., Vol. 101, No. 1, 314-19 (Jan. 1, 1956).

Based upon recent developments of hydromagnetic turbulence, the interaction of a cosmic-ray particle and a moving interstellar cloud is investigated. It is found that the particle can be accelerated by an inductive mechanism with a comparable efficiency to Fermi's mechanisms of collision. However, the efficiency is the highest when the particle is trapped between two interstellar clouds and is accelerated by the combined action of the two mechanisms in a "push-pull" manner. It is suggested that cosmic radiations are primarily accelerated by such a "push-pull" mechanism in some favourable regions in our galaxy. A.

523.165 : 537.591.1

2618. MODIFIED FERMI MECHANISM FOR THE ACCELERATION OF COSMIC RAYS. L.Davis, Jr.
Phys. Rev., Vol. 101, No. 1, 351-8 (Jan. 1, 1956).

Fermi's treatments of the acceleration of cosmic rays are generalized by including the statistical fluctuations in the number of accelerating and decelerating interactions of a particle with a varying magnetic field. This alone does not greatly change the result, a power-law energy spectrum still being obtained. However, interactions, not considered by Fermi, in which the average energy change is zero may now contribute much, or all, of the acceleration. In particular, in his second model, where the galactic magnetic field is roughly uniform along the spiral arm of the galaxy, standing hydromagnetic waves now accelerate and decelerate particles by "betatron" collisions. To get the observed energy spectrum requires r.m.s. gas velocities of 10 km/sec in oscillations whose extensions normal to and parallel to the field are of order 1 and 7 light years, respectively. The observed near-isotropy of cosmic rays may be explained by inhomogeneities in the magnetic field of scale small compared to the helix radius. These can be numerous enough to produce near-isotropy without being so numerous that the particle is less likely to diffuse to the end of the spiral arm than to make a nuclear collision. It is speculated that, because of the statistical effects, fluctuating stellar magnetic fields may accelerate a few particles in a small-scale version of Fermi's first model and thus solve the injection problem. A.

523.51

2619. URANIUM CONTENT OF TWO IRON METEORITES. G.W.Reed and A.Turkevich.
Nature (London), Vol. 176, 794-5 (Oct. 22, 1955).

Two meteorites (Tamarugal and Thunda) have been studied by neutron activation analysis and compared with a 'mock meteorite' synthetically made containing a known quantity of uranium. Both the Ba^{140} and Np^{239} produced by the neutron bombardment were studied. In neither case did the activity decay according to the expected time scale and so there was some contamination which means that only upper limits can be given to the uranium content. Both methods agree and the authors feel that they have not detected uranium in iron meteorites; over half their results set an upper limit below 5×10^{-10} gm/gm. J.M.Hough

523.745 : 523.164.32

2620. INFLUENCE OF THE AGE OF A CENTRE OF ACTIVITY OF RADIO EMISSION ON ITS RADIATION AT CENTIMETRIC WAVELENGTHS. B.Vauquois.
C.R. Acad. Sci. (Paris), Vol. 241, No. 12, 739-40 (Sept. 19, 1955). In French.

The emission of the solar disk, F, is represented by the relation $F = F_0 + \Sigma A(t)k(t)\phi(\theta)$, where F_0 is the background intensity, A the true area of a spot, $\phi(\theta)$ the inclination factor, and k(t) a proportionality constant. The function k(t) is found by least squares from observations of F and A, on a wavelength of 10.7 cm. k(t) is found to be constant for about 15 days after the appearance of the active centre, but then increases; thus, after about 15 days, the rate of decrease of spot area is greater than the rate of decrease of radio emission.
M.W.Ovenden

523.854.3

2621. THE MASS OF THE GALAXY. W.Lohmann.
Z. Phys., Vol. 144, No. 1-3, 66-75 (1956). In German.

A critical discussion is given of Kurth's estimate (Abstr. 2349/1951) which was based on an application of the virial theorem to the observed motion of the globular clusters. Estimates M, based on clusters whose distances from the galactic centre are greater than or equal to R, are plotted as a function of 1/R. A final estimate of 2.35×10^{11} solar masses is obtained by extrapolation as 1/R tends to zero. An independent estimate of 2.5×10^{11} solar masses is obtained under the assumption that the globular clusters move in elongated rather than circular orbits, the motion approximating to radial oscillations through the galactic centre. R.A.Newing

PHYSICS 53

FUNDAMENTALS 530.1

53 : 378

2622. IMPROVEMENT OF TEACHING AS A FACTOR IN THE PRODUCTION OF PHYSICISTS. J.W.Buchta.
Amer. J. Phys., Vol. 24, No. 3, 155-6 (March, 1956).

The small number of physicists in training is a matter of national concern. The quality of the teaching of physics and the attention given the undergraduate students are here considered as factors contributing to the present difficulties. A.

53.081

2623. A MISCONCEPTION CONCERNING DIMENSIONS, STANDARDS AND UNITS. A.J.O'Leary.
Amer. J. Phys., Vol. 23, No. 8, 546-7 (Nov., 1955).

It is pointed out that Merritt's argument (Abstr. 2388/1955) is based on a misconception and that Bridgman's view is the more realistic. In particular permeability may be assigned dimensions or not, so long as the reciprocal of permeability times permittivity in the same system of units has the dimensions of speed squared. S.Weintroub

53.081 : 537.71

2624. RATIONALIZED MKS SYSTEM OF UNITS. S.Chapman.
Amer. J. Phys., Vol. 24, No. 3, 162-6 (March, 1956).

The m.k.s. system of units is explained and compared

with the Gaussian system (and its components, the c.g.s. electrostatic system and c.g.s. electromagnetic system). It is suggested that the m.k.s. system is the easier system to use. Symbols, dimensions, units, and equivalents are given for the most important electric and magnetic quantities. Many of the more common equations are written in both systems, and a simple scheme for conversion is presented. A.

530.12

2625. REMARK ON THE THREE OBSERVED EFFECTS OF GENERAL RELATIVITY. L.Jánossy.
Acta phys. Hungar., Vol. 5, No. 2, 215-28 (1955).

The three observed effects supporting the general theory of relativity are interpreted in a purely phenomenological manner. It is shown what kind of ad hoc assumptions about the effects of the gravitational potential on physical quantities are suitable to account for the three effects. A.

530.12

2626. CONTRIBUTIONS TO THE THEORY OF STATIC VACUUM FIELDS IN THE CLASSICAL AND EXTENDED RELATIVISTIC THEORIES OF GRAVITATION. J.Ehlers.
Z. Phys., Vol. 143, No. 2, 239-48 (1955). In German.

Previous work (Abstr. 5851/1955) is extended to include Majumdar's (1947) general relation $\eta^2(\phi - b)^2 = e^{2\psi} + a/\eta^2$ between electrostatic and gravitational fields, and the Ricci tensor for the 3-space defined by dl^2 is expressed in terms of a single function V such that $d\psi = \eta^2(\phi - b)dV$. The special case a = 0 corresponds to the Euclidean 3-space previously considered. Reissner and Schwarzschild spherically symmetric solutions, and Weyl's axially symmetric solution also follow as special cases. Analogous results are obtained for the Jordan–Thiry theory, it being shown that, for static fields, the most general relation between the functions κ and ψ is of the form $\kappa = \kappa_0 e^{2b\psi}$, where κ_0 and b are constants.
R.A.Newing

530.12

2627. ON THE APPROXIMATE EQUATIONS OF THE EINSTEIN–SCHRÖDINGER THEORY. II. M.A.Tonnelat.
C.R. Acad. Sci. (Paris), Vol. 241, No. 17, 1110-12 (Oct. 24, 1955). In French.

A previous approx. (Abstr. 8473/1955) for small $g_{\mu\nu}$ is used to obtain the electromagnetic and gravitational equations to the second order under the assumption that the $g_{\mu\nu}$ differ from Galilean values by 1st order small quantities.
R.A.Newing

530.12

2628. THE GENERAL SOLUTION OF EINSTEIN'S EQUATIONS $g^{\mu\nu}_{+-};\rho = 0$. S.Mavridès
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1141-64 (Dec., 1955). In French.

The rigorous calculation of these equations leads, for the affine connection, to a simple uniquely determined and completely explicit expression, in function of the contravariant components ($h^{\mu\nu} = g^{\mu\nu}$ and $f^{\mu\nu} = g^{\mu\nu}$) of the fundamental tensor $g^{\mu\nu}$. The existence conditions of this general solution are also given in explicit form. A.

530.12

2629. ON THE CHOICE OF THE METRIC IN UNIFIED (FIELD) THEORY. Pham Tan Hoang.
C.R. Acad. Sci. (Paris), Vol. 241, No. 25, 1919-21 (Dec. 19, 1955). In French.

The gravitational tensor is taken to be $b_{\mu\nu} = Jh_{\mu\nu}$, where $h^{\mu\nu} = g^{\mu\nu}$, and it is then shown that the invariant $J = \sqrt{(g/h)}$. R.A.Newing

530.12

2630. ON THE GRAVITATIONAL FIELD OF A ROTATING MASS. H.Hönl and A.W.Maue.
Z. Phys., Vol. 144, No. 1-3, 152-67 (1956). In German.

In a reconsideration of Thirring's application (1918) of linearized field equations in a calculation of the field inside a rotating spherical shell, an attempt is made to allow for elastic stress in the shell. The centrifugal forces become reduced by a factor of one half. The well known analogy between the linearized equations and the equations of motion of a charged particle is used in a discussion of the gravitational field outside a rotating mass. R.A.Newing

530.12

2631. ON THE GRAVITATIONAL DISPLACEMENT OF SPECTRAL LINES. W.H.McCrea.
Proc. Roy. Irish Acad. A, Vol. 57, No. 11, 173-81 (Jan., 1956).

Simple derivations of the standard formula for the gravitational line-shift are given, treating the problem as one of (a) frequency, (b) energy. It is shown that the formula applies to the change in the amount of any "parcel" of energy that moves in a gravitational field. The interpretation of the results and of their application is discussed, and the status of the line-shift phenomenon as a test of the theory of general relativity is examined. A.

530.12

2632. POSSIBILITY OF UNEQUAL GRAVITATIONAL AND INERTIAL MASSES. R.H.Kraichnan.
Phys. Rev., Vol. 101, No. 1, 482-8 (Jan. 1, 1956).

Lorentz-invariant theories are considered in which a tensor gravitational field obeying a Euclidean wave equation has nonzero coupling to the gravitational self-energy tensor. It is pointed out that the field equations of such theories must be of generally covariant form in regions outside matter. It is found that when the coupling of the energy tensor of matter to the field is not identical with that of the gravitational self-energy tensor, weak-field solutions of the field equations cannot describe observed gravitational phenomena. Further, it is shown that weak-field solutions would be inadmissible if there should exist different kinds of matter for which the phenomenological gravitational force constant takes different nonzero values. The question of the existence of strong-field solutions in these cases is discussed. The results cited are obtained by the use of a Lorentz-invariant variational principle which expresses the restriction on group freedom imposed by the presence in the total Lagrangian of the nongenerally covariant matter terms. The use of an elaborate approximation procedure is not required and the form of the generally covariant field equations in empty space need not be given explicitly. A.

530.12 : 523.11

2633. ON THE QUESTION OF THE FINITENESS OF THE UNIVERSE. K.Just.
Z. Phys., Vol. 142, No. 4, 387-95 (1955). In German.

In a critical discussion of present methods of estimating the spatial curvature, it is emphasized that it is not possible, on the basis of present observations, to determine whether the universe is closed, Euclidean or hyperbolic. Zwicky's morphological methods may provide the most efficient means of investigating space structure, but would be effective only if the radius ρ_0 of the universe were of the same order of magnitude as the age t_0. If ρ_0 were much greater than t_0, it would not be possible to distinguish by present methods between the three possible spatial structures. R.A.Newing

530.12 : 531.18

2634. RESULTANT MOMENTUM AND KINETIC ENERGY IN RELATIVISTIC MECHANICS. R.K.Pathria.
Amer. J. Phys., Vol. 24, No. 1, 47-8 (Jan., 1956).

If the momenta of a particle relative to a system S are p_1 and P when the momenta relative to S' are respectively O and p_2, it is shown that $P = \beta_2 p_1 + \beta_1 p_2$, where $\beta = \sqrt{[1 + (p/mc)^2]}$. A corresponding relation is derived for the relativistic energies of the particle. R.A.Newing

530.145

2635. GENERALIZATION OF A THEOREM OF BLOCH. D.Pfirsch.
Z. Phys., Vol. 144, No. 1-3, 80-4 (1956). In German.

A general quantum-theoretical formulation is given of Bloch's theorem that the state of lowest free energy always carries zero current. It is pointed out that a non-zero current is possible for metastable equilibrium states.

E.H.Sondheimer

530.145 : 539.11 : 539.15/.18

2636. THEORETICAL PHYSICS. J.F.Allen.
Nature (London), Vol. 177, 268-9 (Feb. 11, 1956).

Brief report of a conference held at St. Andrews in November, 1955.

530.145

2637. ON A HAMILTONIAN COVARIANT FORMULATION OF THE CLASSICAL THEORY OF FIELDS. P.Bocchieri and A.Loinger.
Nuovo Cimento (Ser.10), Vol. 2, No. 5, 1058-62 (Nov., 1955). In Italian.

Quantization leads directly to the Glauber–Yang–Feldman equations, which are equivalent to the Tomonaga–Schwinger theory. A.

530.145

2638. ASYMPTOTIC BEHAVIOUR OF THE ELECTROMAGNETIC POLARIZATION OF THE VACUUM IN THE PRESENCE OF MESON INTERACTIONS. V.B.Berestetskiĭ.
Zh. éksper. teor. Fiz., Vol. 29, No. 5(11), 585-98 (1955). In Russian.

In the calculation of Landau et al. (1954) only the contribution of the electron–positron vacuum to the photon propagator D_F is calculated. Here the meson field is included, but in the approximation $e^2 \ll g^2 \ll 1$. The asymptotic Green's function is then calculated by the method of Landau et al. It is found to be the same as if the meson field were absent, i.e., as if $g^2 = 0$. G.E.Brown

530.145

2639. OVER-ALL SPACE-TIME DESCRIPTION AND THIRD QUANTIZATION. Y.Katayama, Z.Tokuoka and K.Yamazaki.
Nuovo Cimento (Ser.10), Vol. 2, No. 4, 728-44 (Oct., 1955).

In order to reformulate quantum field theory from the over-all space-time point of view, Feynman amplitudes constructed by second quantized operators are studied. In treating these Feynman amplitudes, third quantized operators, which create or annihilate second quantized operators, are introduced. These third quantized operators are embedded in a new Hilbert space and operate upon the state vectors in this space. The connection between this formulation and the usual second quantized theory is investigated. It is shown that the authors' formalism is equivalent to Coester's theory. Finally, employing the third quantization formalism, a possibility of further extension of the over-all space-time description is discussed. A.

530.145

2640. ON THE VACUUM CURRENT. S.T.Ma.
Nuclear Physics, Vol. 1, No. 2, 112-18 (1956).

Contains a discussion of some formulae for the vacuum current which can be derived from quantized relativistic electron theory without recourse to perturbation method. A.

530.145

2641. STRUCTURE OF GREEN'S FUNCTIONS IN QUANTUM FIELD THEORY. II. Y.Nambu.
Phys. Rev., Vol. 101, No. 1, 459-67 (Jan. 1, 1956).

In continuation of previous work (Abstr. 57/1956), it is shown that Green's functions of general order, which involve an arbitrary number of field operators, can be represented as parametric integrals with invariant energy denominators and real spectral functions. The analysis is carried out in detail in the case of neutral scalar fields, but a brief discussion is also made of spinor fields. The (renormalized) equations of motion which give a connection between the Green's functions of different order are converted into the corresponding equations for the spectral functions, which proves that the formulae are consistent and manifestly renormalized, with no infinities inherent in them. A.

530.145

2642. ON THE FLUCTUATIONS OF A QUANTIZED FIELD AND THE "STRUCTURE" OF THE PHOTON. C.M.Kotin.
C.R. Acad. Sci. (Paris), Vol. 242, No. 1, 71-3 (Jan. 4, 1956). In French.

First order correlations between energy density fluctuations at two neighbouring points are investigated for the zero-point vacuum field and for a radiation field containing a single photon. Non-zero correlations are taken as an indication of photon structure. R.A.Newing

530.145

2643. GREEN'S FUNCTION IN SCALAR ELECTRODYNAMICS IN THE REGION OF SMALL MOMENTA. A.A.Logunov.
Zh. éksper. teor. Fiz., Vol. 29, No. 6(12), 871-4 (1955). In Russian.

The complete particle Green's function is considered; quantities are renormalized and approximations different from those of the usual perturbation theory are made so as to avoid the infrared catastrophe. G.E.Brown

530.145

2644. THE SELF-STRESS PROBLEM AND THE LIMITS OF VALIDITY OF QUANTIZED FIELD THEORIES. E.Arnous and W.Heitler.
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1282-96 (Dec., 1955).

The conditions for the vanishing of the self-stress of a particle are investigated in a general manner. The following types of fields and interactions are considered: electromagnetic field, electrons, scalar or pseudoscalar mesons, nucleons, with the usual interactions including both types of meson–nucleon interaction, and the five types of beta-decay interaction. It is shown that the self-stress of any of these particles vanishes if its exact self-energy at rest is a homogeneous function of the theoretical masses of all existing particles. The condition can easily be fulfilled if a suitable invariant cut-off is introduced. From the mass difference of charged and neutral π-mesons the cut-off momentum can be determined and it turns out to be of the order of the nucleon mass. It is conjectured that this has universal significance. It is shown that the changes introduced by such a cut-off in quantum electrodynamics are beyond the reach of present experiments. The implications on meson theory are discussed. A.

530.145 : 538.1

2645. RESEARCHES ON THE THEORY OF CORPUSCLES. R.Reulos.
Ann. Inst. Fourier, Vol. 5, 455-568 (1953-54). In French.

The replacement of expressions involving 3-vectors in classical mechanics by 4-vectors and tensors in Minkowski space-time is discussed, and an attempt is made to represent acceleration and Coriolis force in terms of the 4-tensor $\partial_i v_j - \partial_j v_i$. The electromagnetic equations are discussed, Maxwell's equations being represented as generalized Cauchy conditions for analytic functions in 4-space; intensities and polarizations are regarded as quantities of the same nature and a momentum-torque tensor is established (see also Abstr. 2899/1955). An analogy is noted between the equations of motion of a charged particle and those for the motion of a particle in a non-Galilean frame of reference. This analogy is assumed to persist when the acceleration field is replaced by a gravitational field and is used in a discussion of the magnetization of rotating bodies. An attempt is made to combine

relativistic particle dynamics with the quantum mechanical wave field associated with particle motion by introducing two 4-component wave functions ϕ and ψ. The relativistic energy equation is implied by 8 algebraic equations relating the components of ϕ and ψ, and a system of wave equations is set up by introducing the momentum operators

$$i\hbar(\partial/\partial x_k) - (e/c)A_k - (m/c)V_k$$

where V_k is a 4-vector defining the inertial gravitational field. The ϕ - and ψ -fields are regarded as real physical fields defining polarization and current density respectively. Neutral particles are regarded as complex systems, and the solution of bi-particle field equations is discussed. R.A.Newing

530.145

2646. HIGH-ENERGY MULTIPLE PHOTON PRODUCTION. R.Arnowitt and S.Deser.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 707-18 (Oct., 1955).

Multiple production of photons by fast elementary particles coupled strongly to the electromagnetic field is treated by semiclassical methods. In this approximation, the photons are treated in a precise quantum mechanical fashion, while the motion of the matter field is obtained by classical means but include radiation reaction effects. As a specific example the magnetic monopole is discussed (and another possible domain of applicability is pointed out). A possible connection with several recent cosmic-ray events is investigated. It is shown that conventional electrodynamic models (including antiparticle annihilation) produce too few photons and magnetic monopoles too many, to account for the observed multiplicities. A.

530.145

2647. RENORMALISATION AND MASS LEVELS. H.Umezawa and A.Visconti.
Nuclear Physics, Vol. 1, No. 1, 20-32 (1956).

The new aspects of the renormalization problem disclosed by the study of Lee's model are discussed from the point of view of the theory of propagators without making any assumptions about the type of interaction, and introducing from the start a spinor particle with a finite number of stable states of different masses. A.

530.145

2648. RENORMALIZATION OF THE MASS OPERATOR. K.A.Johnson.
Phys. Rev., Vol. 101, No. 1, 448-51 (Jan. 1, 1956).

The renormalizability of the mass operator for all of the usually discussed field theories is established in a general fashion outside of the framework of perturbation theory. A.

530.145

2649. INTERACTION OF ANTIPROTONS WITH NUCLEAR FIELDS. H.P.Duerr and E.Teller.
Phys. Rev., Vol. 101, No. 1, 494-5 (Jan. 1, 1956).

A heuristic argument is given for expecting a strong interaction between antiprotons and nuclear matter. Rough estimates are made for cross-sections of antiprotons on a medium heavy nucleus. P.T.Matthews

530.145

2650. PERTURBATION TREATMENT OF THE MANY-BODY PROBLEM. W.J.Swiatecki.
Phys. Rev., Vol. 101, No. 4, 1321-5 (Feb. 15, 1956).

In the conventional perturbation treatment of the many-body problem of interacting particles, the zero-order Hamiltonian corresponds to independent particles moving in a static over-all potential. A discussion of the effects of particle interactions or "correlations" shows that if one starts instead with a Hamiltonian presenting noninteracting particles in a velocity-dependent over-all potential, deeper for slow, and shallower for fast particles, then part of the correlation effect is included already in zero order. In addition, a velocity-dependent over-all potential may be called for by velocity dependent inter-particle forces or by exchange forces. The degree of the improvement in the convergence of a perturbation expansion based on a Hamiltonian with a velocity-dependent over-all potential is discussed and illustrated by a simple example in which the velocity dependence of the potential gives rise to a reduced "effective mass" of the particles. The many-body problem of a large uniform system of interacting particles (e.g., the case of a heavy nucleus without surface effects) is formulated in detail in perturbation theory, starting with a velocity-dependent potential constant in space. The work involved in such a calculation turns out to be essentially the same as with a velocity-independent potential, the effect of the velocity dependence being to reduce each term in the perturbation expansion by a constant factor raised to a power equal to the number of "energy denominators" $E_m - E_n$ in the term in question. A simple equation is deduced for the optimum degree of velocity dependence of the over-all potential which ensures the most rapid convergence. A.

530.145

2651. ON THE THEORY OF THE EQUATIONS FOR PARTICLES WITH A SINGLE SPIN $\frac{3}{2}$ AND WITH A SINGLE PROPER MASS. I.Úlehla.
Mat.-Fyz. Časopis. Slovensk. Akad.Vied, Vol. 4, 11-27 (1954). In Czech, with summary in Russian.

A formalism for the treatment of the particles is developed. Conditions are specified in order that the wave equation describe particles of a single mass value. Interaction with the electromagnetic field is introduced in the usual way and for the gyromagnetic factor the value $g = \frac{2}{3}$ is obtained in non-relativistic approximation. It is suggested that the μ -meson could be a particle of this type.
Mathematical Reviews

530.145

2652. THE CONFIGURATIONAL EQUATION OF PHOTONS. W.Królikowski.
Acta phys. Polon., Vol. 14, No. 3, 197-207 (1955).

A covariant configuration theory of bosons is developed on the example of photons. The first part of the paper contains a configurational representation of the state vector. For this purpose the mixed representation of the Günther type is used in which N photons are treated configurationally while the electrons and the remaining photons may be treated in any other way one likes. In the second part of this paper a configurational equation is derived for photons, corresponding to the Salpeter–Bethe equation. A.

530.145

2653. ON THE CLASSIFICATION OF FUNDAMENTAL PARTICLES. A.Salam.and J.C.Polkinghorne.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 685-90 (Oct., 1955).

A new four-dimensional isotopic spin formalism is developed for the heavy fundamental particles. All particles correspond to single-valued representations of the rotation group and there is complete symmetry between the isotopic properties of fermions and bosons. The resulting classification is similar to Gell-Mann's except that the degeneracy in the classification of the K-mesons is removed. The forms of the strong interactions are given explicitly. The physical consequences of the theory are discussed in detail. In particular it predicts the existence of a neutral K-meson of lifetime about 10^{-10} sec. A new experimental technique for detecting this particle is suggested. A.

530.145

2654. ON CONSERVATION LAWS IN PRODUCTION AND ANNIHILATION OF ANTINUCLEONS. D.Amati and B.Vitale.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 719-27 (Oct., 1955).

The role played by conservation laws and selection rules is analysed for production and annihilation of antinucleons. The cross-sections for these processes are developed in terms of the independent cross-sections for the transitions

which conserve the total isotopic spin. In addition, the initial and final states are analysed and selection rules are stated for the different processes. A.

530.145

2655. REPRESENTATIONS OF THE DUFFIN–KEMMER ALGEBRAS. K.M.Case.
Phys. Rev., Vol. 101, No. 1, 439-48 (Jan. 1, 1956).

All irreducible representations of the generalized Duffin–Kemmer algebra are constructed by a fusion-theoretical method. This is shown to yield a very convenient form for the representations in terms of which detailed properties are readily investigated. In particular the occurrence of twin representations is shown to be not only analogous to, but indeed a consequence of, the corresponding phenomenon for spinor algebras. A.

530.145

2656. MESONS AND FIELDS. Volume 2. H.A.Bethe and F.de Hoffmann.
Evanston, Illinois: Row, Peterson and Company (1955) ix+ 44 pp.

Review in Brit. J. appl. Phys., Vol. 7, No. 2, 81 (Feb., 1956). "To a newcomer into meson physics an up-to-date survey with an emphasis on the interplay between experimental and theoretical results will be a boon of first importance: the strictly mechanical benefit of less frequent visits to the Physical Review is not negligible. To those familiar with some branch of the physics of mesons a critical appraisal of the present position in other aspects of the subject such as meson-nucleon scattering, the theory of nuclear forces, meson production in gamma or proton collisions on nuclei or (the content of the last two sections) other mesons than the π-meson is most welcome.

530.145

2657. THE TAMM–DANCOFF METHOD. V.P.Silin and V.Ya.Fainberg.
Uspekhi fiz. Nauk, Vol. 56, No. 4, 569-635 (1955). In Russian.

Perturbation theory is not completely successful in its treatment of quantum meson dynamics. It is necessary to use methods of solution not associated with step-by-step analysis of the interaction constant. One such method, to which much effort has been devoted in the last three years is that of Tamm and Dancoff. The present article sets out the bases of the method and its application to various concrete problems of the quantum theory of mesons. The old T.–D. method is discussed in conventional and covariant forms and its application to the interaction of nucleons, interaction of π-mesons etc. The new T.–D. method is also applied to these problems. C.R.S.Manders

530.145

2658. SINGULAR POTENTIALS IN RELATIVISTIC EQUATIONS OF MOTION. J.Werle.
Acta phys. Polon., Vol. 14, No. 3, 233-49 (1955).

It is shown that in the relativistic equations of motion for a particle moving in external potentials some additional forces of purely relativistic origin appear. These forces are repulsive for scalar and pseudoscalar potentials in spite of the apparently attractive character of the potential; they prevent the particle from coming too near to the singularity of the potential. An adiabatic approximation of the interaction potential for two nucleons interacting through the pseudoscalar field has been obtained. An interesting feature of this potential is a strong repulsive term acting at short distances between the nucleons. A.

530.145

2659. MULTIPLE SCATTERING PHASE SHIFTS AND NUCLEAR POTENTIAL. K.Hasegawa and S.Azuma.
Progr. theor. Phys., Vol. 13, No. 4, 360-6 (April, 1955).

The relation between the self-energy of a source-particle and the phase shifts of field quanta scattered by the source was discussed by Sawada (1953). Analogous considerations are extended to the case of two source-nucleons, interacting with the scalar pair mesons. In this case the scattering problem can be exactly solved in the adiabatic limit. The sum of the phase shifts from the S-matrix can be evaluated and it can be shown that the self-energy of the two-nucleon system thus obtained is equal to the sum of twice the single nucleon self-energy and the nuclear potential, the latter being just identical with that deduced by Wentzel. A.

530.145

2660. POINT TRANSFORMATION AND ITS APPLICATION. S.Nakai.
Progr. theor. Phys., Vol. 13, No. 4, 380-8 (April, 1955).

A change of variables in the Lagrangian is investigated. It is then proved that a limited kind of such transformations in the Lagrangian leads to the extended point transformations in the Hamiltonian and this modification of the Lagrangian is, therefore, equivalent to the corresponding unitary transformation of the Hamiltonian. It is obviously more convenient to use the former method to get the transformed Hamiltonian. As illustrative examples, Case–Dyson–Foldy transformation and the elimination of longitudinal photons in quantum electrodynamics are considered. A.

530.145

2661. ON HIGHER ORDER CORRECTIONS IN THE MESON THEORY OF NUCLEAR FORCES. S.Machida and K.Senba.
Progr. theor. Phys., Vol. 13, No. 4, 389-404 (April, 1955).

Effects of higher-order corrections to the second-plus-fourth-order adiabatic nuclear potentials are discussed in the symmetrical pseudoscalar meson theory with pseudovector coupling, in order to make clear the region of its applicability For that purpose the sixth-order adiabatic potentials were calculated, taking into account only terms relating to the case where mesons emitted by a nucleon are absorbed by another nucleon. Although the nuclear potential in the triplet even state changes its sign according as intermediate states with only two nucleons are included or not, the second-plus-fourth-order adiabatic potentials are not altered seriously by the inclusion of the sixth-order effects in the "outside region". Effects of the binding of the two nucleons in the intermediate states are also estimated, this turning out to be unimportant in the "outside region". Accordingly, the second-plus-fourth-order adiabatic potentials have a sufficiently large region of applicability for low-energy phenomena. A.

530.145

2662. THE DETERMINATION OF THE SCATTERING POTENTIAL FROM THE SPECTRAL MEASURE FUNCTION. I. CONTINUOUS SPECTRUM. I.Kay and H.E.Moses.
Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 917-61 (Nov., 1955).

It is shown how a generalized form of the Gelfand–Levitan procedure for obtaining scattering potentials from spectral measure functions may be obtained from the theory of operators in a vector space. The case where the perturbed and unperturbed Hamiltonians have the same spectrum, which is taken to be purely continuous, is treated. The vector space used is Hilbert space. A.

530.145

2663. ASYMPTOTIC EXPANSIONS OF PHASE SHIFTS AT HIGH ENERGIES. M.Verde.
Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 1001-14 (Nov., 1955).

Asymptotic expansions are given for large values of the momentum, considering central static potentials only. For non-singular potentials a recurrence relation which allows the calculation of terms of every order in $1/p$ is established. For potentials which are singular as $1/r$ at the origin, or regular for all angular momenta, the expansions are explicitly written neglecting terms of the order $1/p^5$. A.

530.145

2664. THE NUCLEON GREEN FUNCTION IN PSEUDOSCALAR MESON THEORY. I. S.F.Edwards.
Proc. Roy. Soc. A, Vol. 232, 371-6 (Nov. 8, 1955).

The method of functional integration has been previously applied to the evaluation of Green functions, in particular to the one-nucleon Green function in the cases of neutral scalar and charged scalar mesons interacting with a static nucleon. This work is extended in this and subsequent papers to pseudoscalar meson theory allowing nucleon recoil. In this paper the formal extension, in particular the inclusion of vacuum polarization effects, is made and the resulting forms discussed. In particular, the comparison between forms arising from the usual interaction of fermions and bosons with the analogous boson-boson forms striking dissimilarity. The reduction of the evaluation of the functional integral is discussed in the abstract following. A.

530.145

2665. THE NUCLEON GREEN FUNCTION IN PSEUDOSCALAR MESON THEORY. II. S.F.Edwards.
Proc. Roy. Soc. A, Vol. 232, 377-89 (Nov. 8, 1955).

Following the formal work of Pt I, a method is proposed to evaluate the functional integral which has been derived for the Green function of one nucleon interacting with a pseudoscalar meson field. The method is basically that of stationary phase taken to its second approximation, and since this approximation where applicable is accurate in the limits of strong and weak coupling constants, it is assumed good in general. There are several difficulties involved in the evaluation, and as far as possible these are isolated and discussed with the aid of models each showing one difficulty alone. Combining these separate points, the evaluation of the functional integral is thereby expressed in terms of the solution of a set of coupled equations which provide a basis for a covariant intermediate coupling approach to the problem. The solution of these equations is not attempted in this paper. A.

530.145

2666. MANY-BODY SCATTERING PROBLEM IN MOMENTUM SPACE. S.N.Biswas.
Proc. Phys. Soc. A, Vol. 68, Pt 12, 1193-5 (Dec., 1955).

A second-order linear integro-differential equation, which occurs in many-body scattering problems, is reduced to a homogeneous integral equation of Fredholm type. The reduction is carried out with the aid of a Hankel transform. This leads to an asymptotic value for the unknown function, and this in turn is used to obtain a formula for the phase shift. Application of the method is made to an equation used by Buckingham and Massey (Proc. Roy. Soc. A, Vol. 179, 123, Oct. 10, 1941) in a treatment of the scattering of neutrons by deuterons. L.S.Goddard

530.145

2667. PHASESHIFT ANALYSIS OF PROTON–PROTON SCATTERING EXPERIMENTS. I. GENERAL FORMULATION. E.Clementel and C.Villi.
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1165-82 (Dec., 1955).

The phase-shift analysis problem of proton–proton scattering experiments is considered. In the approximation of S and P waves, a parametrization method is given by which, using directly the experimental data, the four phase-shifts for the singlet S and the triplet P state can be derived. If the contribution of D waves and the effect of the coupling $^3P_2 - {}^3F_2$ is included, it is shown that the problem can still be solved resorting to a polynomial method. A.

530.145

2668. MATHEMATICAL FORMULATION OF THE GELL–MANN MODEL. B.d'Espagnat and J.Prentki.
Nuclear Physics, Vol. 1, No. 1, 33-53 (1956). In French.

It is shown that an axiomatic formulation of the model is possible. Different kinds of fields are formally introduced which are defined by their transformation properties in ordinary (Lorentz) space and isobaric space, the latter being three-dimensional. The fundamental assumption is that the Lagrangian for strong interactions must be invariant under rotation and reflection in isobaric space. Also postulated are the Lorentz invariance and the conservation of baryons. The most general form of strong interaction Lagrangian that follows from these assumptions is derived, and from this the constants of motion I_3 and N are deduced, as well as a new constant U. Up to this point no assumption has been made concerning the charges of the quanta of the various fields. The constant U allows for a definition of charge and, if the charges of N and Λ^0 are postulated, one has the general relation $Q = I_3 + U/2$ for all particles. The values of U deduced from the theory turn out to be precisely those postulated in the Gell–Mann model. In fact a complete equivalence with this model is so obtained. Possibilities of introducing other fields are investigated. It is shown that in most cases some difficulties arise for the definition of U (and therefore of Q). Two different approaches are then possible: (i) In the Lagrangian constructed according to the above rules some interaction terms may be suppressed and new fields can so be introduced. This procedure however cannot be achieved without some degree of arbitrariness. (ii) The following point of view can be adopted: A set of fields is self-consistent only when all the true scalars constructed with these fields can, without contradiction, appear in the Lagrangian. This approach is perhaps more satisfactory for, while not being in contradiction with present experimental data, it is at the same time more elegant and may provide a useful means of limiting the number of fields. A.

530.145

2669. PRINCIPAL AXIS TRANSFORMATION FOR A FREE NUCLEON COUPLED TO AN UNCHARGED SCALAR MESON FIELD. K.McVoy and H.Steinwedel.
Nuclear Physics, Vol. 1, No. 3, 164-79 (1956).

The Hamiltonian for a free nucleon coupled to an uncharged scalar meson field is transformed to normal modes after dropping all terms higher than quadratic in the (field and particle) variables. The resulting normal modes represent scattering states and the "runaway solutions" well-known from the corresponding electromagnetic case, whereas no excited states of the nucleon occur. A.

530.145

2670. THEORY OF THE NEGATIVE PROTON. J.McConnell.
Nuclear Physics, Vol. 1, No. 3, 202-28 (1956).

A method of calculating approximately cross-sections for negative proton production according to the ps-pv and ps-ps meson theories is given. The loss of negative protons by annihilation and by meson production is discussed. An application of the results shows that it is difficult to detect the negative proton in cosmic radiation. A.

530.145

2671. ON THE SCATTERING OF PARTICLES WITH SPIN $\frac{1}{2}$. I. RELATIVISTIC TREATMENT OF THE SCATTERING. B.Stech.
Z. Phys., Vol. 144, No. 1-3, 214-18 (1956). In German.

With the use of the Foldy–Wouthuysen transformation the scattering amplitudes of relativistic particles are reduced to those of the type met in the non-relativistic problem and it is shown that the relativistic treatment does not introduce any new essential features. G.E.Brown

530.145

2672. ON THE SCATTERING OF PARTICLES WITH SPIN $\frac{1}{2}$. II. THE SCATTERING MATRIX AS A FUNCTION OF THE SCATTERING PHASES.
Z. Phys., Vol. 144, No. 1-3, 219-25 (1956). In German.

An explicit construction in terms of phase shifts is given. G.E.Brown

530.145

2673. CENTRE-OF-MASS STATE VECTORS. J.Hamilton.
Proc. Cambridge Phil. Soc., Vol. 52, Pt 1, 97-106 (1956).

The properties of centre-of-mass systems at high energies are discussed, and the single time form of field theory is used to set up state vectors that describe the simpler centre-of-mass states of fields. These states, which are labelled by the eigenvalues of total angular momentum, are expanded in terms of the spherical harmonic resolution of the fields about a fixed point. A discussion of the application of the method to pion–nucleon scattering is given. A.

530.145

2674. EFFECT OF THE FAILURE OF ISOTOPIC SPIN CONSERVATION ON THE PION-NUCLEON S WAVES. H.P.Noyes.
Phys. Rev., Vol. 101, No. 1, 320-3 (Jan. 1, 1956).

The charge-dependent effects of the $\pi^- - \pi^0$ mass difference, the Coulomb interaction, and the $\pi^- + p \rightarrow \gamma + n$ radiative transition are calculated phenomenologically using a charge-independent potential model for the pion-nucleon nuclear S-state interaction. It is found that the charge-exchange S-wave-scattering is little affected but that the transition rate for a bound π^- meson (Panofsky effect) is suppressed about 10%, removing the discrepancy between the difference in scattering lengths as calculated from scattering and from the Panofsky effect. However, it is also found that there can be 25% corrections to the π^- elastic scattering amplitude of either sign, making the precise analysis of low-energy π^- elastic scattering experiments difficult. A.

530.145

2675. KINETIC ENERGY IN NONLINEAR MESON THEORY. D.H.Holland.
Phys. Rev., Vol. 101, No. 1, 451-2 (Jan. 1, 1956).

An alternative definition of the gradient terms in the lattice space quantization method is used to calculate the energy of a nonlinear meson. The expansion in powers of momentum agrees somewhat better with the relativistic expansion that the result previously reported by Schiff. A.

530.145

2676. LOW'S SCATTERING EQUATION FOR THE CHARGED AND NEUTRAL SCALAR THEORIES. L.Castillejo,R.H.Dalitz and F.J.Dyson.
Phys. Rev., Vol. 101, No. 1, 453-8 (Jan. 1, 1956).

The Low scattering equation is studied in the one-meson approximation with both charged and neutral scalar meson theories. The general solution is found for each of these cases. It has the general character of a Wigner-Eisenbud dispersion formula and contains an infinite number of adjustable parameters. It follows that the Low equation, in this approximation at least, does not determine the scattering, but only expresses a property of the scattering which is independent of the internal structure of the scatterer. A.

530.145

2677. PION-NUCLEON S-WAVE PHASE SHIFTS FROM PS-PS WITH CUTOFF. C.J.Goebel.
Phys. Rev., Vol. 101, No. 1, 468-82 (Jan. 1, 1956).

An investigation of the pion-nucleon s-wave scattering in the ps-ps theory is made, using a cutoff $\leq$ the nucleon mass, and the ("exact") Foldy nonrelativistic transformation of the Hamiltonian. The phase shifts are calculated approximately in the three-meson Tamm–Dancoff approximation, however, without inclusion of the meson-meson interaction. No appreciable isotopic-spin dependence is found. A.

530.145

2678. THEORY OF TIME-DEPENDENT SCATTERING FOR MULTICHANNEL PROCESSES. H.Ekstein.
Phys. Rev., Vol. 101, No. 2, 880-90 (Jan. 15, 1956).

The existing time-dependent formal theory of scattering is valid only for the simplest case. The theory is extended to the general case of rearrangement collisions including the case where all or some particles are indistinguishable. The outstanding feature of the scattering process is the existence of asymptotically constant observables. The formal expression of this fact is the existence of a set of basis function ϕ_n such that, if the Schrödinger state is written as a linear combination $\int c(n,t) \exp(-iE_n t)\phi_n dn$, the coefficients c have time-independent limits $c_+(n)$ for $t = \pm\infty$, the squares of which are observed probabilities. While in the simplest case the ϕ_n's are eigenfunctions of the unperturbed Hamiltonian, they form in general a nonorthogonal and linearly not-independent set which can be explicitly given, but there exists no linear operator of which they are eigenfunctions. As a consequence, it is impossible to define an interaction representation in which the states have asymptotic limits, and no linear S-operator exists. An S-matrix is defined, and it is shown to be connected with cross-sections in the usual manner. An expression for the S-matrix in terms of time-independent solutions is given and shown to reduce to the usual one in the simplest case, but not in general. An integral equation for the scattering amplitude is given which is nonlinear. It has, however, the advantage of exhibiting directly the contribution of bound states in addition to Born's approximation. Unitarity and reciprocity relations for the general case are derived. A.

530.145

2679. ANOMALOUS MAGNETIC MOMENT OF THE NUCLEON AND THE PION-NUCLEON SCATTERING. H.Miyazawa.
Phys. Rev., Vol. 101, No. 5, 1564-9 (March 1, 1956).

The anomalous magnetic moment of the nucleon is calculated using the method developed by Chew and Low. The static model is used, i.e., recoil and nucleon pair creation are omitted. The anomalous moments are expressed exactly in terms of the renormalized coupling constant and pion-nucleon scattering cross-sections. The result shows a satisfactory agreement for the magnetic moment arising from the pion current. The contribution from the nucleon current, however, turns out to be too large. It is concluded that the Sachs' mirror condition cannot be satisfied with the simple static model. A.

530.145

2680. EFFECTIVE-RANGE APPROACH TO THE LOW-ENERGY p-WAVE PION-NUCLEON INTERACTION. G.F.Chew amd F.E.Low.
Phys. Rev., Vol. 101, No. 5, 1570-9 (March 1, 1956).

The theory of p-wave pion-nucleon scattering is reexamined using the formalism proposed by one of the authors (F.E.L.). On the basis of the cut-off Yukawa theory without nuclear recoil it is found, for not too high values of the coupling constant, that: (a) For each p-wave phase-shift a certain function of the cotangent should be approximately linear at low energies and should extrapolate to the Born approximation at zero total energy. The value of the renormalized unrationalized coupling constant determined in this way from experiment is $f^2 = 0.08$. A special feature of the predicted energy dependence of the phase shifts is that δ_{33} is positive and the other p phase shifts are negative. (b) The so-called "crossing theorem" requires a relation between the four p phase shifts, so that in addition to the coupling constant only two further constants are needed to completely specify the low-energy behaviour. (c) The direction of the energy variation in the (3, 3) state is such that a resonance will occur for a sufficiently large cut-off ω_{max}. Rough estimates indicate that $\omega_{max} \approx 6$ will produce a resonance at the energy required by experiment. It is argued that the results (a) and (b) are very probably also consequences of a relativistic theory but that (c) may not be. A.

530.145

2681. THEORY OF PHOTOMESON PRODUCTION AT LOW ENERGIES. G.F.Chew and F.E.Low.
Phys. Rev., Vol. 101, No. 5, 1579-87 (March 1, 1956).

The problem of photomeson production is re-examined

using the static model of the pion-nucleon interaction. It is shown that an important part of the low-energy matrix element can be exactly expressed as a function of the scattering phase-shifts and the static nucleon magnetic moments. It is argued that the remainder is quite accurately given by the usual Born approximation. Corrections to this result, within the framework of the "one-meson" approximation, are considered. A.

530.145

2682. REMARKS ON SCATTERING THEORY. R.G.Newton.
Phys. Rev., Vol. 101, No. 5, 1588-96 (March 1, 1956).

Some consequences of the construction of potentials from phase shifts are derived. The question of selecting a unique potential by asymptotic requirements, and the connection with analyticity of the S-matrix is discussed. An expression for the variational derivative of the potential with respect to the phase shift is derived. A simple exact relation between the value of the potential at the origin and the first moment of the phase shift emerges as a result. The variational derivative is made the basis of a "phase-shift perturbation method". One "unperturbed" S-matrix suggests itself naturally, and is here called the "intrinsic" S-matrix of the bound state. The "intrinsic" potential is discussed. Variational derivatives of one phase shift with respect to another, as well as an extension of the phase-shift perturbation method near the intrinsic S-matrix to the presence of a tensor force, are given. A.

530.145

2683. INVARIANT THEORETICAL INTERPRETATION OF INTERACTION. R.Utiyama.
Phys. Rev., Vol. 101, No. 5, 1597-667 (March 1, 1956).

Some systems of fields are considered which are invariant under a certain group transformations depending on n parameters. A general rule is obtained for introducing a new field in a definite way with a definite type of interaction with the original fields by postulating the invariance of these systems under a wider group derived by replacing the parameters of the original group with a set of arbitrary functions. The transformation character of this new field under the wider group is determined from the invariance postulate. The possible types of the equations of the new fields can be also derived, giving rise to a certain conservation law owing to the invariance. As examples, the electromagnetic, the gravitational and the Yang-Mills fields are reconsidered following this line of approach. A.

530.145 : 778.34

2684. A NEW MULTIPLE SCATTERING PARAMETER. H.J.Lipkin, S.Rosendorff and G.Yekutieli.
Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 1015-28 (Nov., 1955).

A new parameter is proposed for the characterization of the multiple scattering observed in tracks of charged particles. This parameter is the mean value of the cosine of a constant times the projected scattering angle. The theoretical relation between the mean value of the cosine parameter and the momentum—velocity product $p\beta$ of the particle can be calculated analytically in a simple way. A theoretical dispersion is also calculable, thereby giving an estimate of the error. This is in contrast to the parameter usually used in track measurements; namely, the mean absolute value of the projected scattering angle where the mean value calculation is complicated and the dispersion is excessively sensitive to the form of the scattering law at large angles. Theoretical results for the mean value and dispersion of the cosine parameter are given for two cases: (1) angles between successive tangents at intervals along the track; (2) angles between successive chords. The effect of the correlation between successive measurements is considered in the latter case. A.

530.145

2685. AN EXTENSION OF THE BORN APPROXIMATION ADAPTED TO THE COULOMB FIELD. J. von Behr and H.Marschall.
Z. Phys., Vol. 143, No. 3, 257-65 (1955). In German.

Coulomb wave functions for a point charge are employed as zero-order functions; deviations from the point charge potential (e.g. due to the finite extent of the nucleus) are considered as perturbations. G.E.Brown

530.145

2686. FREDHOLM THEORY AND HANKEL TRANSFORM OF THE SCHRÖDINGER EQUATION. S.N.Biswas.
Indian J. Phys., Vol. 29, No. 7, 309-18 (July, 1955).

The Fredholm theory of integral equation has been applied to the Hankel transform of the radial part of the Schrödinger wave equation for the determination of phase shifts corresponding to the S, P, D, etc. waves. The numerical results of the S-wave phase shift have been compared with similar ones obtained by other approximate methods. The Hankel transform of the Schrödinger equation is parallel to the Fourier transform of the same as investigated by Bethe and Salpeter. A.

530.145

2687. BOUNDARY CONDITIONS IN THE QUANTUM THEORY OF DISPERSION. E.Minardi.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 799-810 (Oct., 1955). In Italian.

A quantum elaboration of the theory is described, which is an approximation different from that of Dirac and Heitler. Through a generalization of the resolving operator in the stationary case as well as in the nonstationary, a solution is found dependent on an arbitrary parameter c, which is more general than the usual perturbative solution and tends towards it in the limit $c \to 0$. This solution is used for the determination of the variation of the shift and the width of the lines of a system when the latter is subjected to a perturbation H'. In fact, introducing the dependence of c on the azimuthal quantum l, c_l may be expressed as a function of the phase shift $\delta_l^{(0)}$ of the unperturbed system and of the perturbation H'; c_l is moreover connected with the phase shift δ_l the perturbed system. The real part of c_l gives the shift of the resonance level, whereas the imaginary part gives the width of the line corresponding to state l. These quantities are thus connected, through $\delta_l^{(0)}$, with the boundary conditions of the unperturbed system. A.

530.145

2688. THE WAVE EQUATION FOR SPIN 1 IN HAMILTONIAN FORM. II. E.Schrödinger.
Proc. Roy. Soc. A, Vol. 232, 435-47 (Nov. 22, 1955).

For Pt I, see Abstr. 4387 (1955). The investigation is mainly concerned with the relation between constants of the motion and the conservation laws in differential form. The operator that commutes with the Hamiltonian is not the one whose Hermitian form obeys a conservation law and therefore yields, on integration over space, the mean (or expectation) value of the constant. There is a general association between the "commuting" and the "conserved" operators; the latter does not in general commute with the Hamiltonian. The duplication stems from normalizing by a non-definite Hermitic form, meaning the charge density. It entails that an elementary wave always carries a positive amount of energy, and a momentum in the direction in which the wave proceeds, though from the eigenvalues of energy and momentum one might expect either sign. A deep-rooted general connection between charge quantization and the energy aspect of frequency is suggested. An attempt is made to clarify the relation between mechanical and magnetic spin, the latter appearing to depend in a simple way on the fifth Kemmer matrix. A

530.145

2689. ENERGY CORRECTIONS AND PERSISTENT PERTURBATION EFFECTS IN CONTINUOUS SPECTRA. L.Van Hove.
Physica, Vol. 21, No. 12, 901-23 (Dec., 1955).

The quantum-mechanical perturbation theory of continuous energy spectra is investigated for a special class of perturbat-

ions possessing some of the formal properties of the familiar interaction energies of field theory. These formal properties entail the inapplicability of the familiar perturbation theory of continuous spectra. The latter, which implies that the perturbation causes transitions between unperturbed stationary states, with conservation of the unperturbed energy, is valid for scattering and reaction processes. The perturbations here considered are found to produce transitions between "asymptotically stationary states" differing from the unperturbed stationary states both by the admixture of other states and by correction of the energy value. This is in agreement with the situation intuitively expected but not explicitly verified in field theory (due to divergence and computational difficulties), according to which the interaction between fields causes, besides scattering, creation or annihilation processes, the persistent occurrence around real particle of a cloud of virtual particles (photon cloud around an electron, meson cloud around a nucleon, etc.), with an accompanying self-energy effect. A.

530.145

2690. DYNAMICAL VARIABLES IN THE BETHE–SALPETER FORMALISM. S.Mandelstam.
Proc. Roy. Soc. A, Vol. 233, 248-66 (Dec. 20, 1955).

It is shown that a knowledge of the behaviour of the propagators around their singularities enables one to determine not only the masses of bound states, but also the matrix element of any dynamical variable between two bound states. One is thus enabled to find such a matrix element, to any order in the coupling constant, by the integration of certain expressions over the corresponding Bethe–Salpeter wave-functions. As a consequence, it is possible to find normalization and orthogonality properties of these wave-functions, which in turn lead to the condition which must be imposed on their singularities at the origin. More light is thus shed on Goldstein's difficulty concerning the existence of a continuous infinity of bound states. The formalism is extended to scattering states in which some of the particles may be composite — in particular, an expression for the S-matrix is obtained. A.

530.145

2691. EXTENSIONS OF THE HILBERT SPACE IN THE QUANTUM THEORY OF WAVE FIELDS. W.Heisenberg.
Z. Phys. Vol. 144, No. 1-3, 1-8 (1956). In German.

The new states in the author's non-linear theory with an extended Hilbert space (Abstr. 8030, 10781/1954, 7705/1955) are compared with the "ghost" states found in the renormalized Lee model (G.Källen and W.Pauli, in the press; T.D.Lee, Abstr. 9936/1954). It is shown that, apart from the indefinite metric common to both theories, energy, momentum and mass can no longer be defined in the new states; any such state is, as it were, a dipole of a normal and a "ghost" state. However, in contrast with the renormalized theory of Lee's model, the S-matrix elements between normal and anomalous states vanish in the non-linear theory, and the S-matrix remains unitary and can be interpreted physically. It is suggested that, provided the S-matrix remains unitary, the use of an extended Hilbert space with indefinite metric may be the most natural way of removing divergencies. W.A.Hepner

530.145

2692. THE JOINING OF INFRA-RED AND ULTRA-VIOLET CALCULATIONS. E.L.Lomon.
Nuclear Physics, Vol. 1, No. 2, 101-11 (1956).

The perturbation radiation corrections to electron scattering diverge as the energy resolution ΔE vanishes. This makes terms of order higher than the first power of the fine-structure constant, α, important for small values of ΔE already obtained experimentally. The Bloch-Nordsieck type calculations show that the high-order, low-energy photon processes are essential, and that the above mentioned divergence is due to the inadequacy of the perturbation method for these processes. However, this type of calculation is invalid for high-energy virtual photons. Using the recent formulation of the Bloch-Nordsieck method, and a perturbation treatment cut off for small photon energies, an expression for certain events is found, correct to any chosen order in α and to first order in a parameter of magnitude less than 10^{-2}. A.

530.145

2693. SINGLE-BODY WAVE FUNCTIONS AND TWO-BODY FORCES. Y.C.Hsieh and I.Bloch.
Phys. Rev., Vol. 101, No. 1, 205-9 (Jan. 1, 1956).

It is found that some of the eigenfunctions of a nuclear Hamiltonian containing Hooke's-law interactions of nucleons can be expressed as independent-particle states. In these states it is more satisfactory to define the nucleons' positions with respect to the centres of mass of the protons and of the neutrons, rather than with respect to a fixed origin. There is some reason to believe that all nuclear bound states can be approximated by means of perturbations from such independent-particle states. A.

530.145

2694. "THEORY OF MEASUREMENT" IN DIFFERENTIAL-SPACE QUANTUM THEORY. A.Siegel and N.Wiener.
Phys. Rev., Vol. 101, No. 1, 429-32 (Jan. 1, 1956).

The "reduction of the wave packet" is an essential feature of the quantum description of measurement. Since it means an abrupt change in the wave-function, it therefore also implies an abrupt change in the statistical description of the system. If the differential-space theory of quantum systems rests on a description of reality more detailed than quantum mechanics, it must contain an account of this change which is consistent with the strictly probabilistic point of view of the theory. It is here shown that the theory does satisfy this necessary condition. The need of a special postulate for the measurement process is eliminated in this formulation, and a new explicitness is introduced into the description. A.

530.145

2695. TRANSFORMATION OF RELATIVISTIC WAVE EQUATIONS. B.Kurşunoğlu.
Phys. Rev., Vol. 101, No. 4, 1419-24 (Feb. 15, 1956).

A unitary transformation is found which transforms the Dirac equation into two uncoupled equations. These involve higher orders of the time derivative than the first. In order $(v/c)^2$ the equations involve only the first time derivative and they are then equivalent to the Foldy-Wouthuysen transformation. While the equations are uncoupled and free of odd operators the functions satisfying them cannot be interpreted as different functions describing positive and negative energies separately, the general interpretation in the exact theory remaining in terms of the four-component wave-function. The transformation is extended to quantized fields and to relativistic two-body equations. The second-order electromagnetic mass effects in the quantized Dirac equation appear, in the nonrelativistic limit, as the time derivatives of the electric terms of the nonrelativistic Hamiltonian without the radiative corrections. These mass effects in the nonrelativistic Hamiltonian are proportional to $(1/mc)^3$. Construction of unitary transformation operators for the ps-ps meson theory and for the Bethe–Salpeter equation are also discussed. A.

530.162

2696. ON THE THEORY OF THE EINSTEIN CONDENSATION. A.Münster.
Z. Phys., Vol. 144, No. 1-3, 197-213 (1956). In German.

The theory of Bose–Einstein condensation is developed on the basis of the author's statistical theory of phase changes (Abstr. 3410/1954), using the grand canonical ensemble. In the three-dimensional case the condensation is interpreted as an anomalous phase change of the first order (J. chem. Phys., Vol. 7, 1019-25, Nov., 1939), for which all co-existing phases possess the same energy and entropy density, and for which the boundary of the quasi-heterogeneous region coincides with the boundary of the distribution in phase. For one or two

dimensions the transformation point moves to the boundary of the distribution in phase, while, in more than three dimensions, the transformation is of higher order than the first.
E.H.Sondheimer

530.162

2697. WAVESTATISTICAL DERIVATION OF THE FORMULA FOR TRANSITION PROBABILITY. S.Sanatani.
Indian J. theor. Phys., Vol. 3, No. 1, 21-6 (March, 1955).

The formula for transition probability, for direct transitions or transitions through intermediate states, is derived by a new method involving χ_1 and χ_2 waves in phase space. A.

530.162

2698. DYNAMICS OF A DISORDERED LINEAR CHAIN. R.Bellman.
Phys. Rev., Vol. 101, No. 1, 19 (Jan. 1, 1956).

A disordered linear chain is defined as a chain of one-dimensional harmonic linear oscillators, each coupled to its nearest neighbours by harmonic forces, with the mass of each oscillator and the coupling parameters taken to be random variables with known distributions. The problem of calculating the distribution function of the frequencies of the normal modes of vibration of the chain in the limit as the chain becomes infinitely long was resolved by Dyson. This paper presents a simple algebraic proof of the essential limit relation in Dyson's paper (Abstr. 3136/1954). A.

530.162 : 536.7

2699. STATISTICAL MECHANICS OF IRREVERSIBLE CHANGE. R.T.Cox.
London: Oxford University Press; Baltimore: The John Hopkins Press (1955), 138 pp. + 6 figs.

The author has based his choice of topics on interest and on a capacity of statistical description without the use of a very complicated notation. The book is divided into four sections entitled The Statistical Theory of Thermodynamic Equilibrium, Viscous Forces and Brownian Motion, Transport Phenomena, and the Constrained Approach to Equilibrium.

530.162 : 537.311.33 : 536.21

2700. EXTENSION OF MCDOUGALL–STONER TABLES OF THE FERMI–DIRAC FUNCTIONS. A.C.Beer, M.N.Chase and P.F.Choquard.
Helv. phys. Acta, Vol. 28, No. 5-6, 529-42 (1955).

The McDougall–Stoner tables of the Fermi–Dirac functions $F_k(\eta)$ for $k = -1/2$, $1/2$ and $3/2$ have been extended to include $k = 5/2$, $7/2$, $9/2$ and $11/2$. Computations were carried out on digital computing equipment, using three terms of the Euler–Maclaurin numerical integration formula. Values are tabulated for the argument $\eta = -4$ (0.1) 20. Analysis of results, including use of numerous check points, suggests that the tables are accurate to five significant figures throughout. In order to provide a complete listing, the McDougall–Stoner values for $F_{-1/2}(\eta)$, $F_{1/2}(\eta)$, and $F_{3/2}(\eta)$ are also included in the tabulations. A.

530.162 : 541.124

2701. BROWNIAN MOTION IN A FIELD OF FORCE AND THE DIFFUSION THEORY OF CHEMICAL REACTIONS. H.C.Brinkman.
Physica, Vol. 22, No. 1, 29-34 (Jan., 1956).

Kramers (1940) derived a diffusion equation in phase space, describing the motion of a particle subject to an external force and to the shuttling action of the Brownian forces caused by a surrounding medium in temperature equilibrium. In this paper a solution of Kramers' equation is obtained by systematic development of the particle density with respect to the Smoluchowski diffusion current operator. It is shown that Smoluchowski's diffusion equation in coordinate space is a first approximation to Kramers' equation, valid if all but the first power of the Smoluchowski current operator may be neglected. The region of validity of the Smoluchowski equation is determined for a particle in a potential well. A.

530.19

2702. A SIMPLE EXPRESSION FOR THE SOLUTION OF THE DIRICHLET PROBLEM IN THE PLANE. E.Durand.
C.R. Acad. Sci. (Paris), Vol. 241, No. 21, 1452-4 (Nov. 21, 1955). In French.

A method involving a conformal transformation is used to derive the expression. The physical significance as the complex potential of an elementary cylindrical dipole is pointed out. Two examples are briefly indicated. L.S.Goddard

GENERAL MECHANICS. MECHANICS OF SOLIDS 531

531.38

2703. MECHANICS DEMONSTRATION. P.O.Hoffmann.
Amer. J. Phys., Vol. 23, No. 9, 624-5 (Dec., 1955).

An apparatus is described to demonstrate visually the difference in angular velocities acquired by a uniform rod which is free to rotate in a vertical plane about a fixed horizontal axis at one end, when the rod is unloaded and when loaded by a spherical mass attached to the free end.
S.Weintroub

531.383 : 539.622

2704. TIPPE TOP (TOPSY-TURNEE TOP) CONTINUED. A.R.Del Campo.
Amer. J. Phys., Vol. 23, No. 8, 544-5 (Nov., 1955).

See Abstr. 3151 (1954) and 6313 (1954). Checks that frictional torque is important in the turnover process by a scrutiny of the energy considerations and by consideration of the special cases when the top is at rest and at the completion of the turnover. S.Weintroub

MECHANICAL MEASUREMENTS 531.7

531.719.24

2705. RELATIVE PRECISION OF RANGE INFORMATION OBTAINABLE WITH FIXED BALLISTIC AND WANDERMARK STEREOSCOPIC RETICLES. G.S.Harker and L.A.Weaver, Jr.
J. Opt. Soc. Amer., Vol. 46, No. 3, 195-200 (March, 1956).

A fixed-reticle stereoscopic range-finding sight, incorporating a reticle in which the elements were distributed in depth and elevation to simulate a trajectory, was evaluated in relation to an optically equal wandermark stereoscopic range finder. Data were obtained on the ranging sensitivity of experienced and naive observers with the two instruments and on the influence of the design of the ballistic reticle upon the observed range of the targets. The primary data obtained with the range-finding sight were in mils of elevation. The primary data obtained with the wandermark range finder were in seconds of arc of convergence. Mathematical transformations were used to reduce the elevation data to equivalent seconds of arc of vergence for purposes of comparison. The problem of repeated measures resulting from the fact that the reticle of the range-finding sight was an in-view range scale was met through the use of optical range adjustment. For the targets employed, standard deviation sensitivity in parallactic angle for experienced observers with the range-finding sight was five and three times poorer than that obtained for these observers with the wandermark range finder. For naive observers the relative sensitivities were in a ratio of four to one and one to one. The reticle of the range-finding sight as designed required an increasingly more negative internal corrector adjustment with increasing range. This tendency was attributed to the use of reticle elements of constant retinal subtense. A

531.752

2706. MAGNETIC SUSPENSION BALANCE. J.W.Beams,

C.W.Hulburt, W.E.Lotz, Jr and R.M.Montague, Jr.
Rev. sci. Instrum., Vol. 26, No. 12, 1181-5 (Dec., 1955).

An analytical balance is decribed in which the materials to be weighed are attached to a ferromagnetic body that is freely suspended by the axial magnetic field of a solenoid. The vertical position of the suspended mass is maintained by the automatic regulation of the current through the solenoid by means of an electronic servo-circuit actuated by a light beam and photomultiplier tube arrangement. The horizontal position of the supported mass is maintained by the symmetrically diverging field of the solenoid. Changes in the nonferromagnetic masses of the suspended bodies are determined by the resulting changes in the current through the solenoid necessary to keep the bodies freely suspended. Masses ranging from 10^5 to 2×10^{-6} gram have been suspended. The precision of the balance is limited only by the natural fluctuations in the circuit, the photomultipliers and the support system. This balance is especially useful where it is necessary to weigh materials inside sealed chambers which contain gases, vapours or liquids, or which are evacuated. A method is described for accurately calibrating the balance. A.

MECHANICS OF FLUIDS 532

532.13 : 532.14

2707. DENSITY AND VISCOSITY MEASUREMENTS ON MERCURY AND VERY DILUTE POTASSIUM AND CAESIUM AMALGAMS FROM THR FREEZING POINT TO 30° C.
R.Suhrmann and E.O.Winter.
Z. Naturforsch., Vol. 10a, No. 12, 985-96 (1955). In German.

The thermal expansion coefficient increases linearly with concentration, faster for Cs than for K amalgam. The specific volume of the amalgams increases linearly with concentration; the deduced atomic volumes of Cs and K differ by only 10%, and are respectively 50% and 30% less than in the pure metal. This contraction decreases with increasing temperature. The temperature-dependence of viscosity is represented within 0.1% by $\eta = \eta_0 \exp q/RT$ with η_0 independent of T; for pure Hg q = 657.9 cal, for K-amalgam of 0.191 at.% concentration q = 714.6 cal, and for the same concentration Cs amalgam q = 690.4. The results are correlated on the basis of regarding the alkali atoms as spheres, smaller than the holes which occur in the mercury, which produce a change in viscosity just as macroscopic spheres would. W.M.Lomer

532.137

2708. A CONTINUOUS-FLOW ROTATIONAL VISCOMETER FOR USE WITH DOWNWARD-SETTLING SUSPENSIONS.
G.F.Eveson and E.W.Hall.
J. sci. Instrum., Vol. 33, No. 3, 110-12 (March, 1956).

A rotational viscometer is described capable of measuring the apparent viscosity of downward-settling suspensions of particles sized below 100 B.S. mesh, where the settling velocity of the particles relative to the dispersion medium is less than 0.2 cm/sec. A.

532.52

2709. ON THE FLOW OF ROTATING FLUID PAST BODIES IN A PIPE. L.E.Fraenkel.
Proc. Roy. Soc. A, Vol. 233, 506-26 (Jan. 10, 1956).

Deals with the flow of a rotating, incompressible fluid through contractions and expansions of a pipe, or past bodies of revolution on the pipe axis. The flow far upstream is assumed to have constant axial velocity, and constant angular velocity about the pipe axis. The flow fields are constructed from the stream functions of a ring source on the pipe wall or of a point source on the pipe axis. These solutions involve wave motions when the angular velocity exceeds a critical value. The point-source solution is expressed in two forms, the first of which is useful some distance from the source, while the second displays more clearly the nature of the singularity and leads to a comparison of the corresponding doublet with Taylor's doublet solution (1922). Some streamline pictures and velocity distributions are presented, and the physical behaviour of a rotating fluid is discussed. A.

532.57 : 621.317.79

2710. EXPERIMENTS ON THE DEPENDENCE OF SENSITIVITY ON VELOCITY PROFILE IN ELECTROMAGNETIC FLOWMETERS. J.A.Shercliff.
J. sci. Instrum., Vol. 32, No. 11, 441-2 (Nov., 1955).

Mercury was passed along a non-conducting circular tube bearing flowmeter-type electrodes situated in a transverse magnetic field downstream of a small offset orifice. When the flow was concentrated near the electrodes the ratio of induced potential difference to the product of magnetic field and flow rate was found to reach more than twice the value appropriate to axially symmetric velocity profiles. When the flow was concentrated at the side of the tube this ratio could fall to zero and even change sign. Further downstream a steady state was reached, sometimes in an oscillatory manner. A.

532.582.5

2711. PRESSURE DISTRIBUTION ON A HYDROFOIL RUNNING NEAR THE WATER SURFACE. B.R.Parkin, B.Perry and T.Y.Wu.
J. appl. Phys., Vol. 27, No. 3, 232-40 (March, 1956).

The effect of the free surface on the pressure distribution on the upper side of a shallow-running hydrofoil is considered from a general point of view. Previous theoretical and experimental work is reviewed in order to compare the range of flow variables for which each treatment of the surface proximity problem is valid. A qualitative theoretical expression for the pressure is developed. This result shows the relative importance of the pertinent parameters, and it is shown to agree qualitatively with previous experiments as well as with new pressure measurements made in the free surface water tunnel. The foregoing considerations reinforce the view generally held in the past, that the principles of potential theory when properly applied to hydrofoils, even at shallow submergences, may be expected to lead to valid and useful results. A.

CAPILLARITY 532.6

532.61

2712. SURFACE TENSION AND FLOATING BODIES.
E.K.Chapin.
Amer. J. Phys., Vol. 24, No. 3, 178 (March, 1956).

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

2713. HOLE THEORY OF LIQUIDS AND THE LATTICE APPROXIMATION. F.C.Goodrich.
J. chem. Phys., Vol. 24, No. 1, 172 (Jan., 1956).

Considering a system of cylindrical identical molecules it is shown that the average potential energy can be calculated without the use of the lattice approximation. It is stated that similar treatment may be employed for systems of molecules of unequal length. T.C.Toye

532.7 : 533.7

2714. REFINEMENT OF THE LENNARD-JONES AND DEVONSHIRE THEORY OF LIQUIDS AND DENSE GASES.
W.J.Taylor.
J. chem. Phys., Vol. 24, No. 2, 454-9 (Feb., 1956).

The Lennard-Jones and Devonshire (LJD) theory of liquids represents an advance over the early free-volume theories, in that each molecule is assumed to move in a potential field generated by its neighbours. However, this potential is the static field computed with each neighbour at its equilibrium position (cell centre), so that the LJD theory does not take account of the correlation of the motion of neighbouring molecules. This correlation problem is treated in the present paper by recasting the exact classical partition function in a form in which the LJD potentials appear in the principal terms, while certain correlation potentials appear in correction terms. The resulting integrals are analogous to those appearing in the conventional theory of an imperfect gas, but with the correlation potential playing the role of the usual intermolecular potential, and the range of integration of each molecule limited to its own cell (where it is also subject to the static LJD potential). A practical method of evaluation of the integrals is developed, based on power series expansions of the factors containing the correlation potentials. The limitation of each molecule to a single cell (single occupancy) is not an essential feature of the theory. The allowance for multiple occupancy of the cells leads to the communal entropy correction, which has been treated by Pople and others. The present correction for correlation of neighbouring molecules is applicable even for single occupancy, and is thus an addition to the communal entropy correction. The method is compared with Kirkwood's self-consistent field modification of the LJD theory, which takes some account of correlation, but only in an average sense. Comparison is also made with the cell-cluster theory of de Boer, antedated by the present work. The two theories are basically equivalent, in spite of their different formulations. It is considered that the present method puts the integrals in a form more practical for calculation. A.

532.72

2715. MAGNITUDE OF DIFFUSIVE DISPLACEMENTS IN LIQUIDS. R.M.Noyes.
J. chem. Phys., Vol. 23, No. 10, 1981-2 (Oct., 1955).

532.72

2716. MEASUREMENT OF THE SORET EFFECT IN POTASSIUM CHLORIDE SOLUTIONS. J.Chanu and J.Lenoble.
C.R. Acad. Sci. (Paris), Vol. 241, No. 17, 1115-17 (Oct. 24, 1955). In French.

Results obtained with 1-3.5 normal solutions by the method reported in Abstr. 5256 (1955). Figures for the diffusion coefficient, deduced from the rate of approach to equilibrium, are also given. H.London

532.73 : 541.123.2

2717. PHASE EQUILIBRIA IN SOLUTIONS OF ROD-LIKE PARTICLES. P.J.Flory.
Proc. Roy. Soc. A, Vol. 234, 73-89 (Jan. 24, 1956).

A partition function for a system of rigid rod-like particles with partial orientation about an axis is derived through the use of a modified lattice model. In the limit of perfect orientation the partition function reduces to the ideal mixing law; for complete disorientation it corresponds to the polymer mixing law for rigid chains. A general expression is given for the free energy of mixing as a function of the mole numbers, the axis ratio of the solute particles, and a disorientation parameter. This function passes through a minimum followed by a maximum with increase in the disorientation parameter, provided the latter exceeds a critical value which is 2e for the pure solute and which increases with dilution. Assigning this parameter the value which minimizes the free energy, the chemical potentials display discontinuities at the concentration at which the minimum first appears. Separation into an isotropic phase and a somewhat more concentrated anisotropic phase arises because of the discontinuity, in confirmation of the theories of Onsager and Isihara, which treat only the second virial coefficient. Phase separation thus arises as a consequence of particle asymmetry, unassisted by an energy term. Whereas for a large-particle asymmetry both phases in equilibrium are predicted to be fairly dilute when mixing is athermal, a comparatively small positive energy of interaction causes the concentration in the anisotropic phase to increase sharply, while the concentration in the isotropic phase becomes vanishingly small. The theory offers a statistical mechanical basis for interpreting precipitation of rod-like colloidal particles with the formation of fibrillar structures such as are prominent in the fibrous proteins. The asymmetry of tobacco mosaic virus particles (with or without inclusion of their electric double layers) is insufficient alone to explain the well-known phase separation which occurs from their dilute solutions at very low ionic strengths. Higher-order interaction between electric double layers appears to be a major factor in bringing about dilute phase separation for these and other asymmetric colloidal particles bearing large charges, as was pointed out previously by Oster. A

532.78

2718. THE DISTRIBUTION OF IMPURITY IN A SEMI-INFINITE SOLIDIFIED MELT. O.W.Memelink.
Proc. Phys. Soc. B, Vol. 69, Pt 1, 119-20 (Jan., 1956).

An expression is obtained for the transient concentration of impurity in a solid, with the solid-liquid interface moving with constant velocity and the diffusion region in the melt being assumed of infinite length. J.Franks

MECHANICS OF GASES 533

533.15/.16 : 536.23 : 536.44 : 532.13

PROPERTIES OF GASES AND LIQUIDS WITHIN THE RANGE OF PRESSURES USED IN INDUSTRY. See Abstr. 1881

533.15 : 539.217.1

2719. MOLECULAR FLOW, FREE AND OBSTRUCTED BY PRESENCE OF A FOREIGN GAS, THROUGH A TUBE BENT SHARPLY IN MANY PLACES AS A MODEL FOR A POROUS SYSTEM. J.W.Hiby and M.Pahl.
Z. Naturforsch., Vol. 11a, No. 1, 80-4 (1956). In German.

A formula is deduced for the flow of molecules along a circular tube (dia. 2a) bent sharply many times to represent a pore in a porous body. The mean free path is considered to be so large that mutual collisions may be neglected. Binary collisions with the molecules of a foreign gas however are considered, the mean free path in respect of these collisions being much greater than the length of a straight section of the tube. The flow of the gas is calculated as a function of the pressure of the foreign gas and the molecular "conductivity" (having the dimensions of a diffusion coeff.) of the pore model compared with that of a long straight tube. W.Good

533.275 : 621.317.79 : 621.319.4

2720. A CAPACITANCE-RESISTANCE HYGROMETER. C.L.Cutting, A.C.Jason and J.L.Wood.
J. sci. Instrum., Vol. 32, No. 11, 425-31 (Nov., 1955).

A new type of hygrometer is described. Indications of relative humidity are given by changes of the electrical properties of anodized aluminium oxide layers. The calibration is independent of temperature from 0 to 80°C, and of the air speed. The instrument is extremely sensitive, and may be easily adapted for continuous recording and control. A theory accounting for the observations is outlined. A

533.275 : 621.317.79 : 621.319.4

2721. THE BEHAVIOUR OF HUMIDITY-SENSITIVE CAPACITORS AT ROOM TEMPERATURES. C.R.Underwood and R.C.Houslip.
J. sci. Instrum., Vol. 32, No. 11, 432-6 (Nov., 1955).

Measurements of the humidity in small enclosed spaces are not easily performed with the conventional types of hygro-

meter, but the capacitance hygrometer (e.g. preceding abstract) enables such measurements to be made. An investigation of the behaviour of the hygrometer at room temperatures was carried out using a divided-flow apparatus and a sensitive dew-point hygrometer. The capacitance hygrometer responded to changes in both temperature and humidity, and an empirical equation relating the impedance of the instrument (measured at 1 kc/s), the air temperature, and the water-vapour pressure, was found. The response of the hygrometer to changes in water-vapour pressure was found to depend on the frequency of the applied potential difference, the sensitivity decreasing as the frequency was increased. The hygrometer followed changes in humidity very rapidly so long as the relative humidity was less than about 80%. At higher relative humidities the response was slow. It was concluded that the behaviour of the instrument was consistent with the adsorption of water-vapour on the dielectric material. The instrument may be of considerable value for measurements in small spaces. A.

MOLECULAR THEORY OF GASES 533.7

533.7

2722. ON THE THEORY OF THE TEMPERATURE JUMP IN A RAREFIED GAS AND ITS EXPERIMENTAL VERIFICATION. H.von Ubisch.
Ark. Fys., Vol. 10, Paper 14, 157-63 (1955).

Earlier published measurements by the author on monatomic gases were in disagreement with the classical theory of the temperature jump, whereas those on diatomic gases fitted Webber's version of this theory. The measurements on monatomic gases however support the more exact theory recently developed by Welander, whereas the behaviour of diatomic gases is dubious here. In view of the intricacy of the problem and some other evidence it is felt that improved experimental investigations would be highly desirable. A.

533.7

2723. COLLISIONS BETWEEN NON-SPHERICAL MOLECULES. I. MOLECULAR COLLISIONS IN HYDROGEN GAS AT LOWER TEMPERATURES. K.Takayanagi and K.Ohno.
Progr. theor. Phys., Vol. 13, No. 3, 243-58 (March, 1955).

Collisions between an atom and a diatomic molecule are theoretically investigated. The detailed calculations are carried out in the special case of hydrogen gas at lower temperatures in order to interpret the observed relation between the viscosity of the gas and the para—ortho concentration ratio. It is found that, by improving the shape of the intermolecular potential, one can avoid the greater part of the discrepancy between the experimental fact and the result of an older theory. However, quantitative explanation of the relation requires more detailed and exhaustive calculations. A.

533.7

2724. CALCULATION OF KINETIC THEORY COLLISION INTEGRALS BY INTERPOLATION. M.J.Reisfeld and E.A.Mason.
J. chem. Phys., Vol. 24, No. 1, 171-2 (Jan., 1956).

A simple method is described by means of which collision integrals for a particular type of intermolecular forces are converted to other types of intermolecular forces. An example is considered showing that this method is superior to the procedure of interpolating collision integrals. R.Eisenschitz

533.7

2725. MATHEMATICAL STUDY OF BOLTZMANN'S EQUATION. S.Marquet.
C.R. Acad. Sci. (Paris), Vol. 242, No. 5, 615-17 (Jan. 30, 1956). In French.

533.7

2726. EXTENSION OF THE CONDENSATION THEORY OF YANG AND LEE TO THE PRESSURE ENSEMBLE. M.B.Lewis amd A.J.F.Siegert.
Phys. Rev., Vol. 101, No. 4, 1227-33 (Feb. 15, 1956).

Phase transitions which occur at or lead to a specific volume larger than the minimum specific volume can be described by roots of the Laplace transform $C_N(s)$ of the canonical partition function approaching real positive values of the pressure (kTs) in the limit of infinite number of particles. The formulation in the pressure ensemble has the advantage that the real values of the variables considered have the immediate physical meaning even for a finite number of particles. For a special model (molecules whose incompressible cores are oriented cubes), a phase transition leading to the minimum specific volume at constant pressure is shown to be impossible. A.

533.7 : 541.64

STATE OF ASSOCIATION OF COPPER HALIDE VAPOURS. See Abstr. 2520

VIBRATIONS. ACOUSTICS 534

534.113

2727. TORSIONAL VIBRATION OF A CYLINDER OF CYLINDRICALLY AEOLOTROPIC MATERIAL. J.G.Chakravorty.
Indian J. theor. Phys., Vol. 3, No. 1, 17-20 (March, 1955).

The problem of torsional vibration of a cylinder of a material with cylindrical aeolotropy about the axis of the cylinder is discussed. An exact solution of the problem has been obtained when the cylinder is either hollow or has an isotropic core. A.

534.113

2728. THE FLEXURAL VIBRATIONS OF AN END-LOADED VERTICAL STRIP. J.P.Ellington.
Brit. J. appl. Phys., Vol. 6, No. 12, 451-2 (Dec., 1955).

A lower limit to the frequency of vibrations is calculated, in the case when a strip is clamped at the upper end and loaded at the lower end. The calculation agrees with the experimental results of Hearmon and Adams (Abstr. 7762/1955). J.G.Oldroyd

534.115

2729. PHOTOGRAPHS OF ACOUSTIC RESONANCE SPECTRA OF LIQUIDS. C.Sălceanu.
C.R. Acad. Sci. (Paris), Vol. 241, No. 16, 1032-3 (Oct. 17, 1955). In French.

Apparatus is described for recording on photographic paper the resonance spectrum of a column of liquid excited at a given frequency. Two curves are given for water when excited at 1363 c/s; one shows two normal resonant peaks and the other four additional secondary maxima. It is not certain whether these secondary maxima depend on the nature of the liquid or whether they arise from vibrations in the test equipment. H.J.H.Starks

534.12 : 548.0

2730. THE PROPAGATION OF SURFACE ELASTIC WAVES IN A CUBIC CRYSTAL. R.Stoneley.
Proc. Roy. Soc. A, Vol. 232, 447-58 (Nov. 22, 1955).

Discusses the possibility of the propagation of elastic waves, analogous to Rayleigh waves or Love waves, over a (0, 0, 1) surface of a cubic crystal. An examination of symmetrical cases in which the direction of propagation is parallel to the x-axis or makes an angle of 45^0 with it shows that waves with amplitude falling off exponentially with distance from the free face do not exist for every set of values of the three elas-

tic constants chosen at random. For crystals of aluminium and copper these Rayleigh-type waves do not exist, but for rock salt their existence is demonstrated both for the symmetrical cases and for an asymmetrical case. In the latter the particles describe ellipses in a plane inclined to the direction of propagation. Waves of Love type can exist only in the two symmetrical cases cited; it is shown that then the general Rayleigh-type motion degenerates into a superposition of Rayleigh waves and Love waves. It is easily seen that for all types of crystals the general result will be the same, but that the algebraical and arithmetical work involved will be extremely heavy. A.

534.141.3

2731. THE EXPERIMENTAL STUDY OF BOWED STRING AND VERIFICATION OF THE FORMULA FOR THE BOWING PRESSURE. R.N.Bagchi and C.Dutta.
Indian J. theor. Phys., Vol. 3, No. 1, 1-16 (March, 1955).

534.141.4

2732. FLOW RELATIONS AT THE LIP OF AN ORGAN PIPE. H.Dänzer and W.Kollmann.
Z. Phys., Vol. 144, No. 1-3, 237-43 (1956). In German.

The electrical analogy method is used for deriving the flow relations at the lip of an organ pipe, and curves are given of the velocity potential distribution along and across the pipe axis in the region of the lip. The results are interpreted in terms of a simple two-dimensional treatment. H.J.H.Starks

534.143

2733. THE POWER RADIATED BY AN ELECTROMECHANICAL WAVE SOURCE. H.Pursey.
Proc. Phys. Soc. B, Vol. 69, Pt 2, 139-44 (Feb., 1956).

Evison (Abstr. 5935/1951) describes an electromechanical wave-source for use in geophysical investigations, and presents an analysis of its behaviour. Several errors in this analysis have since been noticed, and in particular the formula for the radiation impedance of the source has now been shown to be incorrect. In the present paper a new analysis is given, based on more accurate radiation formulae, and taking account of the mutual admittance of the elements of the source. The results are shown to be in agreement with an estimate of radiated power made by Evison on the basis of measurements of the received signal at points distant from the source. The present paper shows that much of the power from Evison's source is radiated in the surface wave, and a method of reducing this loss is described. A.

534.152

2734. ON THE RESONANT VIBRATIONS OF THICK BARIUM TITANATE DISKS. E.A.G.Shaw.
J. Acoust. Soc. Amer., Vol. 28, No. 1, 38-50 (Jan., 1956).

An optical interference technique employing stroboscopically illuminated multiple beam Fizeau fringes has been used to study the surface motion of varium titanate disks. In a properly polarized, accurately shaped cylindrical disk only normal modes having symmetry with respect to the axis and to the central plane are observed. A particular disk having radius/semithickness ratio (a/l) of 3.86 has been studied in some detail, and the displacement patterns for three important modes in the thickness resonance region have been accurately measured. Stress distributions for these three modes have been calculated from theory and these show that the wave motion is of a complex character in all three cases; this question is discussed in the light of elementary conceptions of thickness resonance. A more comprehensive experimental survey covering 25 different values of a/l within the range 1.14 to 6.63 has now been completed, and vibration patterns of 12 modes are given together with graphs of resonance frequency and values of electromechanical coupling coefficient. At relatively low frequencies the observed modes are obviously of the radial type but as the frequency approaches a value such that $2.51 = \Lambda_s$ where Λ_s is the wavelength of Rayleigh waves, take the form of a surface wave resonance with maximum motion occurring at the edge of the disk. There is no single mod which can be uniquely identified as the fundamental dilatationa thickness resonance. Rather, as a/l changes, each mode in turn passes through a maximum or minimum of electromechan ical coupling in the thickness resonance region. In general, for any given value of a/l two or three modes have high coupling in this region, and the vibration patterns have certain well defined forms but none approaches uniform piston-like motion. Nevertheless, there is some evidence suggesting an optimum value of a/l in transducer design. A.

534.171

2735. PHASE SHIFTS AND THE DOPPLER EFFECT. W.C.Michels.
Amer. J. Phys., Vol. 24, No. 2, 51-3 (Feb., 1956).

If the path between a source S and an observer O is changed by an amount Δx, the phase of the wave received by O is shifted by $\Delta n = -\Delta x/\lambda = -f\Delta x/c$, where λ and f are, respectively, the wavelength and frequency of the disturbance and c is the speed of propagation, all measured by an observer fixed in the medium. The resulting change in observed frequency is $\Delta f = \Delta n/\Delta t$, where Δt is the time taken for the observation of the phase change. It is shown that these two statements are sufficient for the derivation of the acoustic Doppler effect equations in all cases. The extension to the relativistic optical Doppler effect also follows if the Einstein time dilatation is taken into account. A.

534.21

2736. ON THE PARTITION OF ENERGY BETWEEN ELASTIC WAVES IN A SEMI-INFINITE SOLID. G.F.Miller and H.Pursey.
Proc. Roy. Soc. A, Vol. 233, 55-69 (Dec. 6, 1955).

Expressions are derived for the power radiated in the compressional, shear and surface waves set up by a circular disk vibrating normally to the free surface of a semi-infinite isotropic solid. The total radiated power is also calculated independently by integrating the displacement velocity over the area of the source. The theory is extended to a general type of multi-element radiator in the form of an array of elements on the circumference of a circle. The calculation of the total power here involves a "mutual admittance" function, a table of which is given for the case when the Poisson's ratio of the medium is equal to ¼. The theory is applied to a three-element radiator of a type used in a recent geophysical investigation, and it is shown that the efficiency of radiation in the compressional mode can be varied between wide limits by varying the distance between the elements. Finally, an approach is suggested for problems in which the most suitable idealized boundary condition is one of known displacement under the radiator, the stress being zero elsewhere on the free surface. It is shown that the stress under the radiator satisfies an integral equation whose kernel is derived from the mutual admittance function. A.

534.21 : 533.6.011.4

2737. SOUND PROPAGATION INTO A MOVING MEDIUM. P.A.Franken and U.Ingard.
J. Acoust. Soc. Amer., Vol. 28, No. 1, 126-7 (Jan., 1956).

In the study of transmission of sound into a moving medium, if flow speeds larger than twice that of sound are allowed, the analysis indicates at least formally the existence of two critical angles between which total reflection occurs. A discussion of the corresponding behaviour of the angle of refraction and the reflection coefficient is presented. A

534.21 : 535.3

2738. INVESTIGATIONS ON THE PROPAGATION OF SIGNALS IN DISPERSING MEDIA WITH AN ACOUSTIC MODEL. T.Ankel.
Z. Phys., Vol. 144, No. 1-3, 120-31 (1956). In German.

The study is based on the theory of Sommerfeld and Brillouin on the propagation of a light signal of specific form

through an optically dispersing medium. The theory is discussed in detail. An acoustic model is constructed. This consists of a long tube to which a Helmholtz resonator can be applied. With this system the theory is tested. There is qualitative agreement with the theoretical prediction. Quantitative agreement is not to be anticipated. S.Tolansky

534.21 : 541.182.6

2739. THE PROPAGATION OF ULTRASONICS IN SUSPENSIONS OF PARTICLES IN A LIQUID. J.Busby and E.G.Richardson.
Proc. Phys. Soc. B, Vol. 69, Pt 2, 193-202 (Feb., 1956)

The propagation of sound in suspensions of solid particles in water in the range of frequency 1 to 10 Mc/s and of particle radius 8 to 100 microns was measured. For the ultrasonic attenuation a pulse method was used, the suspension being either monodisperse (glass spheres) or polydisperse (silica particles). In the latter suspension the particle size distribution was measured optically. Results are compared with a theory due to Sewell and others and good agreement obtained. The ultrasonic absorption is linear with concentration up to 18% by volume. Some measurements were also made on "sediments" of glass spheres and natural sands in which the attenuation is high and increases rapidly with frequency and particle size. A.

534.22

2740. TEMPERATURE DEPENDENCE OF ULTRASONIC VELOCITY IN AMYL ACETATE-TOLUENE MIXTURES. G.S.Verma and S.K.Kor.
J. chem Phys., Vol. 24, No. 1, 163-4 (Jan., 1956)

In the case of both pure liquids and in their mixtures the velocity is found to decrease with temperature but not uniformly. Maximum and minimum rates of decrease have in fact been established at two temperature regions for pure amyl acetate and all the mixtures studied. The maximum and minimum positions are however slightly different for toluene than for the other liquids. T.C.Toye

534.22 : 539.132

2741. ULTRASONIC DISPERSION IN HALO-ETHYLENE VAPOURS. P.G.T.Fogg and J.D.Lambert.
Proc. Roy. Soc. A, Vol. 232, 537-47 (Nov. 22, 1955).

The velocity and absorption of ultrasonic waves have been measured by acoustic interferometer in the vapours of vinyl fluoride, chloride, bromide and iodide, vinylidene fluoride, cis-dichloro-ethylene, trans-dichloro-ethylene, trichloro-ethylene and tetrafluoro-ethylene at 100°C and for values of f/p ranging from 100 kc/s.atm^{-1} to 15 Mc/s.atm^{-1}. All show dispersion or incipient dispersion, and single relaxation times appear to control the whole of the molecular vibrational energy in each case. The results are correlated with previous results for halo-methane vapours and for other polyatomic molecules. The conclusion is drawn that vibrational activation enters a molecule via the mode of lowest frequency. The probability of excitation of that mode in collision is a function both of its frequency and of the intensity of its infrared activity. In most cases a strongly infrared active mode is very much more easily excited by collision than an inactive mode of the same frequency. The paper includes second virial coefficient data for all the vapours investigated. A.

534.22 : 539.3

2742. NOTE ON THE PAPER BY L.Y.TU, J.N.BRENNAN, AND J.A.SAUER ON DISPERSION OF ULTRASONIC PULSE VELOCITY IN CYLINDRICAL RODS. M.C.Junger.
J. Acoust. Soc. Amer., Vol. 27, No. 5, 974 (Sept., 1955).
See Abstr. 6826 (1955).

534.222.2

2743. ANALYTICAL TREATMENT OF POWERFUL, PLANE, NON-STATIONARY SHOCK WAVES. W.Häfele.
Z. Naturforsch., Vol. 10a, No. 12, 1005-15 (1955). In German.

The work of von Weizsäcker (Abstr. 8109/1954), and Hain and v.Hoerner (Abstr. 2509/1955) relating to shock waves, and based on the work of Taylor (Abstr. 4777/1950) and of Guderley (Luftfahrtforschung, Vol. 19, 302, 1942) is extended. It is shown that shock waves having different initial distributions tend increasingly with the passage of time, towards a homologous solution. Such plane solutions are studied by means of Guderley's method; a single such solution is derived and discussed for ratios (ρ) of specific heats respectively equal to 1.1, 1.4, 1.66 and 2.8; a simple, explicit, analytical solution for the case $\rho = 1$ is derived. This solution is characterized by a markedly linear velocity distribution, while for the other values of ρ the velocity distribution is approximately linear. The approximation, in the course of time, of non-homologous types of shock waves to the homologous types discussed in the paper is discussed. J.S.G.Thomas

534.222.2

2744. THE STABILITY OF THE TYPE OF SHOCK WAVES INCLUDED IN THE CLASS OF HOMOLOGOUS SOLUTIONS. W.Häfele.
Z. Naturforsch., Vol. 10a, No. 12, 1016-20 (1955). In German.

The approximation of non-homologous types of shock waves to homologous type of solution reported in the preceding abstract is further discussed and it is shown that consideration of stability is dependent upon the phenomenon of reversible edges, which is somewhat clarified. Knowledge of the homologous type of solution is presumed. J.S.G.Thomas

534.222.2

2745. THE NORMAL MOTION OF A SHOCK WAVE THROUGH A NON-UNIFORM ONE-DIMENSIONAL MEDIUM. R.F.Chisnell.
Proc. Roy. Soc. A, Vol. 232, 350-70 (Nov. 8, 1955).

The non-uniform medium is regarded as a succession of small-density discontinuities separated by uniform regions. Consideration of the interaction of a shock wave with a weak contact discontinuity gives a first-order relationship between change in shock strength and change in density across the discontinuity, which is integrated to give the shock strength as a function of the initial density of the non-uniform medium in closed form. Due to the passage of the shock, a wave is reflected back through the non-uniform medium, generating in turn a doubly reflected wave which eventually catches up the shock. A complete description of the flow as modified by the first reflected wave is obtained. The modifications to the flow caused by the doubly reflected wave are more difficult to formulate, and a complete description of the flow so modified is not given. The extra difficulty is partly due to the dependence of the doubly reflected wave on the initial density distribution, whereas the motion of the incident shock, and the flow behind it as modified only by the first reflected wave, are found to have the useful property that they are independent of the particular density-distance distribution being considered. Calculations of the total strength of the doubly reflected wave, and the strength of the incident shock when this wave has fully merged with it, have been made for a particular density distribution. A comparison of this calculated strength with the strength of the shock transmitted, after the interaction of a shock wave and a contact discontinuity, suggests that a description of the flow which takes account only of the single and double reflection is satisfactory, even if the initial density distribution varies considerably. A.

534.222.2

2746. ATTENUATION IN THE SHOCK TUBE: I. LAMINAR FLOW. R.N.Hollyer, Jr.
J. appl. Phys., Vol. 27, No. 3, 253-61 (March, 1956).

The ideal flow predicted for an inviscid adiabatic shock tube is not realized in experiments. A correction of the ideal theory for the viscous stresses and heat losses arising from the interaction of the gas flow with the tube walls is calculated.

The boundary layer is regarded as a distribution of sinks of energy and momentum. The actual distribution is approximated by that behind a constant strength shock front and is calculated for laminar flows. The change in shock strength caused by a single sink located at a fixed distance behind the shock front is determined and this result is integrated over the distribution previously calculated. Interactions between the expanding compression chamber gas and the wall are neglected. It is shown by comparison with experiment that the interactions treated account for the major part of the attenuation of the shock front. It is pointed out that more data are required to evaluate precisely the assumptions used in the calculation. A.

534.222.2

2747. DETONATION WAVE FRONTS IN IDEAL AND NON-IDEAL DETONATION. M.A.Cook, G.S.Horsley, R.T.Keyes, W.S.Partridge and W.O.Ursenbach.
J. appl. Phys., Vol. 27, No. 3, 269-77 (March, 1956).

Extensive wave shape data are presented for various (effectively) unconfined explosives over wide ranges of diameter d, length L, density ρ_1, and physical conditions. Observed wave fronts were invariably spherical segments with radii of curvature R increasing at first directly with L(R = L), but eventually becoming steady at a constant value R_m/d between 0.5 and 4 depending on the charge diameter primarily through the ratio a_o/d (a_o = reaction zone length). At the critical diameter of propagation (large a_o/d) R_m/d approached 0.5, and at large diameter (small a_o/d) it approached or levelled off at the upper limit of about four. The upper limit ($R_m/d \sim 4$) is apparently a restriction imposed by the fundamental nature of detonation of solid explosives with free boundaries. A.

534.222.2 : 536.46

2748. IGNITION OF COMBUSTIBLE GASES BY CONVERGING SHOCK WAVES. J.A.Fay and E.Lekawa.
J. appl. Phys., Vol. 27, No. 3, 261-6 (March, 1956).

Hydrogen-oxygen and hydrogen-air mixtures were ignited by converging cylindrical shock waves using the apparatus devised by Perry and Kantrowitz (Abstr. 6802/1951) and the minimum strength shock wave necessary for ignition was determined. The enthalpy increase in the wake of the shock wave within a cylinder of diameter equal to the quenching distance and of unit height was calculated and found to be comparable with the minimum spark ignition energy divided by the quenching distance. An analysis of the unsteady heat conduction problem lends support to the choice of the quenching distance as the significant dimension of the region over which heat addition is effective in causing ignition. A.

534.23

2749. ULTRASONIC ABSORPTION IN CASTOR OIL, CARBON DISULPHIDE, BENZENE AND XYLENE. A.K.Dutta and K.Samal.
Nature (London), Vol. 174, 976-7 (Nov. 20, 1954).

See abstract following.

534.23

2750. A NEW THERMAL METHOD FOR SOUND ABSORPTION IN LIQUIDS. S.Parthasarathy, M.Pancholy and C.B.Tipnis.
Nature (London), Vol. 176, 611 (Sept. 24, 1955).

The thermal method (Abstr. 6558/1953) developed by the authors has been used by Dutta and Samal (preceding abstract) for work on C_6H_6 and CS_2; their results do not agree with other methods. The authors have checked on this and find agreement, therefore concluding that Dutta and Samal are in error in some way. T.C.Toye

534.23 : 532.74

2751. ABSORPTION OF ULTRASONICS AND ASSOCIATION IN SOLUTIONS OF PHENOL IN CCl_4, C_6H_{12} AND C_6H_5Cl. A.Mez and W.Maier.
Z. Naturforsch, Vol. 10a, No. 12, 997-1004 (1955). In German.

An optical method is used to determine the total absorption and that due to the solute. The various factors contributing to the complete absorption coefficient are very well discussed in the light of observations. T.C.Toye

534.23 : 534.26

2752. SOUND ABSORPTION COEFFICIENTS BASED ON INTENSITY MEASUREMENTS OF DIFFRACTION ORDERS. C.Raghupathi Rao.
Proc. Indian Acad. Sci. A, Vol. 42, No. 6, 331-5 (Dec., 1955)

Sound absorption coefficients for a large number of liquids are determined by using a 931-A photomultiplier tube. Observations are made on the zero-order diffraction spectrum, the change in intensity of this spectrum being an index of the sound absorption in liquids. The method gives satisfactory results over a wide frequency range from 7 to 50 Mc/s. A.

534.232

2753. SOUND RADIATION FROM THE ACOUSTIC BOUNDARY LAYER. U.Ingard and D.Pridmore-Brown.
J. Acoust. Soc. Amer., Vol. 28, No. 1, 128-9 (Jan., 1956).

The sound radiated from a finite rectangular plate in an infinite wall oscillating in shear motion is calculated. The order of magnitude of the intensity of this sound field is compared with that which is produced when the plane oscillates with the same amplitude in a direction normal to its surface. A.

534.232 : 538.551

2754. EQUIVALENT CIRCUITS OF MAGNETOSTRICTIVE TRANSDUCERS. H.Jørsboe.
Acustica, Vol. 5, No. 4, 219-22 (1955).

A simple derivation is given of the equivalent electrical circuit of a magnetostrictive transducer with distributed mass and compliance and with stress orthogonal to magnetic field by the method of establishing equivalent circuits for each element of the transducer and then connecting them. In the second part of the article the ring vibrator is considered and an equivalent circuit is obtained, the constants of which are compared with those found by Butterworth and Smith. A.

534.26

2755. INTENSITY MEASUREMENTS OF ULTRASONIC DIFFRACTION ORDERS. C.Raghupathi Rao.
Proc. Indian Acad. Sci. A, Vol. 42, No. 3, 158-62 (Sept., 1955).

Quantitative intensity measurements on v.h.f. ultrasonic diffraction orders in the range 3 to 170 Mc/s have been made for the first time employing a modern photomultiplier tube. This method of measurement has proved far superior to other intensity measuring techniques described in the literature. Two important aspects of high-frequency diffraction have been studied and explained in the light of Brillouin's theory. A.

534.26 : 541.182.6

2756. DURATION OF THE DIFFRACTION GRATING IN RELATION TO THE STATE OF THE POWDERS IN SUSPENSION. A.Carrelli and F.S.Gaeta.
Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 898-903 (Nov., 1955).

It has been observed that the diffraction grating discovered by Carrelli and Porreca in liquid suspensions of powders builds up only after a certain time after the mixing of the two phases. Working with aqueous suspensions of perfectly dried powders the authors have measured for different substances in water the times necessary for the gradual establishment of the phenomenon and have emphasized a dependence of these times upon the nature of the phases in contact and their temperature. A

534.26 : 541.182.6

2757. ON THE PERSISTENCE OF A PHASE GRATING IN SOME SUSPENSIONS WHEN STOPPING THE SUPERSONIC WAVES. F.Porreca.

Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 904-6 (Nov., 1955).

It has been observed that in substances which present the effect of persistence of the even diffraction lines, the trace of the ultrasonic grating built up during the passage of ultrasound persists for a certain time after the ultrasound has ceased. This trace, consisting of parallel equally luminous lines equally spaced by $\lambda_{u.s.}/2$ is the same as that observed during the action of ultrasound. This result is identical with that obtained with an artificial phase grating and gives direct proof that a phase grating of constant $\lambda_{u.s.}/2$ persists. A.

534.372

2758. MODEL EXPERIMENTS ON THE DAMPING OF FLEXURAL WAVES AT CORNERS. G.Kurtze, K.Tamm and S.Vogel.

Acustica, Vol. 5, No. 4, 223-33 (1955). In German.

The reflection and transmission of flexural waves at a right-angled corner of two Plexiglas rods, as well as the energy in the secondary extensional waves set up in front of and behind the corner, are separately measured with a directional pick-up. At the corner a rigid connection, then an elastic one built up with a layer of damping material, and finally a link connection is made. The frequency range is 0.2 to 2.0 kc/s and the wavelength large compared to the cross-section (3 x 3 cm^2) of the rods. The results agree with Cremer's theory. To clarify the motional relationships for the three corner connections, phase measurements were made along the strips. A.

534.6

2759. A VERSATILE AUDIO SPECTROMETER. W.O.Essler.

I.R.E. Trans Audio, Vol. AU-3, No. 2, 24-7 (March-April, 1955).

A new method of obtaining power spectra is described. Advantages of the new method are speed of use and great frequency detail. The method is based on the production of a "composite signal" which has a time-continuous power spectrum. The composite signal method can be used with many types of signals such as speech, music, traffic noise, etc. A.

534.612.4

2760. ACOUSTIC CALIBRATION STANDARDS. F.Spandöck.

Acustica, Vol. 5, No. 4, 197-207 (1955). In German.

Two acoustic sources are developed as standards. One gives a constant static noise, that of spheres falling on a membrane; the other produces a sound pressure in an enclosed chamber from the driving of a highly-tuned oscillating plate as piston source. With the latter a complete response curve can be covered. Examples of the constancy of the sources are given. The technique of the calibration and sources of error are discussed. For free-field calibration the correction of the sound pressure for diffraction is measured by an electrostatic contrivance. Finally certain aspects of the precision in practice of acoustical standardization are discussed. A.

534.614

2761. DETERMINATION OF SHEAR WAVE VELOCITIES IN ISOTROPIC SOLIDS BY A MODIFIED WEDGE METHOD. B.Ramachandra Rao and P.Venugopala Rao.

Acustica, Vol. 5, No. 4, 217-18 (1955).

The principle and experimental details of a new method of determining the shear wave velocities in isotropic media is described. Shear wave velocities are determined in some metals and some Indian rock specimens and are compared with those obtained by other methods. The advantages of this method are briefly discussed. A.

534.7

PHYSIOLOGICAL ACOUSTICS. HEARING. See also under "Medical science. Human physiology". Decimal classification 612.85.

534.844 : 534.846.4

2762. STEREO REVERBERATION. R.Vermeulen.

Philips tech. Rev., Vol. 17, No. 9, 258-66 (March, 1956).

Halls unsuitable for concerts can be given better acoustics for music by providing artificial diffuse reverberation. An installation is described with which such "stereo reverberation" can be provided electro-acoustically. It is based on a so-called "delay-wheel", the rim of which is coated with a material suitable for magnetic sound recording. A recording head records the music performed. A number of play-back heads (say, four or six) around the circumference of the rotating wheel pick up the recorded sound with predetermined time lags, and separately feed a group of loudspeakers, mounted throughout the hall. The intensity of each group is independently controllable, and the time lags can be regulated by the speed of the wheel. The sound is picked up by one or two "line microphones", each consisting of ten condenser microphones with strongly directional characteristics, to reduce the possibility of continuous "howl-back". It has been shown that such an installation can produce a great improvement in the musical acoustics of a hall. Other possible applications of stereo reverberations are also discussed: in broadcasting studios, in the cinema and in the "duplication" of concerts. A.

534.846.4

2763. HISTORICAL NOTE ON THE HAAS EFFECT. R.D.Fay and W.M.Hall.

J. Acoust. Soc. Amer., Vol. 28, No. 1, 131-2 (Jan., 1956).

Reminder that the effect was investigated in 1935.

OPTICS. RADIATION. SPECTRA 535

535.237

2764. CALCULATION OF RADIANT PHOTOELECTRIC SENSITIVITY FROM LUMINOUS SENSITIVITY. R.W.Engstrom.

RCA Rev., Vol. 16, No. 1, 116-21 (March, 1955).

Describes a simple method by which the luminous sensitivities usually specified for commercial photoelectric devices may be converted to radiant sensitivities. Mathematical expressions are presented to illustrate the derivation of the relationship, and tables are given to facilitate practical conversion. A typical analysis is included for a phototube having an S-1 spectral-response characteristic. A.

535.241.33 : 621.326.3

2765. SECONDARY STANDARD LAMPS FOR PHOTOMETRIC AND COLORIMETRIC PURPOSES. R.E.Leeds and G.T.Winch.

G.E.C. J., Vol. 22, No. 4, 232-6 (Oct., 1955).

A description is given of an improved design of uniplanar tungsten filament vacuum lamp suitable for use as a secondary standard of directional intensity. Improved designs of tungsten filament gas-filled lamps suitable for use as secondary standards of luminous flux are also described. Data are given of the stability of good-quality general lighting service fluorescent tubes of current manufacture, which, it is shown, are sufficiently stable for use to a limited extent as secondary standards in photometric and colorimetric applications.

C.E.Williams (R)

535.247.4

2766. PEAK PULSE BRIGHTNESS PHOTOMETER. L.Wijnberg.

Rev. sci. Instrum., Vol. 27, No. 2, 94-6 (Feb., 1956).

A photometer is described for measuring the peak brightness of light flashes 0.3 microsec in duration and 10^{-3} $in.^2$ in cross-sectional area. A telescope and beamsplitter arrangement permits convenient and rapid aiming. The light flashes are sensed by a photomultiplier tube, and the resultant electrical signals are transmitted to a pulse lengthener with appro-

priate 0.1 microsec rise time circuitry. A single transient will fully deflect the output meter for a period of five seconds. A.

535.247.4 : 621.383.27 : 621.317.79

2767. A WIDE RANGE, RECORDING, LOGARITHMIC PHOTOMETER CIRCUIT. P.Hariharan and M.S.Bhalla.
J. sci. Instrum., Vol. 33, No. 2, 69-71 (Feb., 1956).

The circuit described uses a photomultiplier tube operated as a range compressor, followed by a logarithmic amplifier, to obtain an accurately logarithmic response over an illumination range greater than 10^6 : 1. It can be utilized, in conjunction with a recording milliammeter or an oscillograph, for brightness v. time measurements wherever extreme brightness ranges are encountered. A.

535.247.4 : 771.534.5

2768. AN INCREMENTAL PHOTOMETER AND OPTICAL MEASUREMENTS IN THE PHOTOGRAPHIC LATENT-IMAGE RANGE. N.R.Nail, F.Moser and F.Urbach.
J. Opt. Soc. Amer., Vol. 46, No. 3, 218-22 (March, 1956).

An instrument for measuring very small changes in optical absorption has been designed and built. It operates with a constant narrow band of wavelengths and can be used for measuring changes in optical density of the order of 10^{-5}. In a second instrument, spectrophotometric operation is attained with some sacrifice in sensitivity. The problems arising in this type of photometry are discussed. The instruments have been constructed primarily for the measurement of the print-out effect in silver halides. In selected photographic emulsions, this effect has been measured in the exposure range of latent-image formation. A.

535.317.1 : 535.42

2769. THE INFLUENCE OF ASTIGMATISM ON THE RESPONSE FUNCTION OF AN OPTICAL SYSTEM. M.De.
Proc. Roy. Soc. A, Vol. 233, 91-104 (Dec. 6, 1955).

An analytical study is made of the response of an astigmatic optical system to spatial frequencies in the object. Curves are given showing the response as a function of line frequency for varying values of astigmatism, the image plane being midway between the sagittal and tangential foci. A simple criterion for testing astigmatic systems is given. Tolerances on astigmatism and Petzval curvature are obtained. A comparison is made with results indicated by geometrical treatment, which shows that the geometrical treatment gives sufficiently accurate results only for low frequencies. A.

535.317.9

2770. ON THE DESIGN OF OPTICAL SYSTEMS CONTAINING ASPHERIC SURFACES. J.Meiron.
J. Opt. Soc. Amer., Vol. 46, No. 4, 288-92 (April, 1956).

Third-order aberration contributions of aspheric surfaces are derived from the point of view of wave theory. The design of a double aspheric curved field anastigmat based on third-order theory is then presented and its performance compared to a similar (Petzval) system consisting solely of spherical surfaces. The control of higher order aberrations and the possibility of increasing the relative aperture of the system with the aid of aspherics are discussed. A.

535.327

2771. CONCERNING INDEX OF REFRACTION AND DENSITY. E.S.Barr.
Amer. J. Phys., Vol. 23, No. 9, 623-4 (Dec., 1955).

By considering the values of refractive index and density of 120 inorganic and 445 organic substances, it is shown that there is only a slight positive correlation between the two properties. It is therefore suggested that the statement that "light is refracted towards the normal on entering a denser medium" is unsound where the terms "denser" refers to density in g/cm^3. N.Corcoran

535.33

2772. MICROWAVE SPECTROSCOPY. C.H.Townes and A.L.Schawlow.
London: McGraw-Hill (1955) xviii + 698 pp.

Review in Brit. J. appl. Phys., Vol. 7, No. 2, 82 (Feb., 1956). "The authors of the present book have endeavoured to give a thorough and critical treatment of the subject, intended mainly for those working in the field. They have succeeded, however, in presenting the material in such a way as to make certain sections of the book an excellent introduction for research students. The first four chapters deal with the spectroscopy of molecules (about 111 pp.); there follow chapters on atomic spectra (30 pp.), hyperfine structures (60 pp), Stark and Zeeman effects (50 pp.), shapes and widths of spectral lines (40 pp.), with a separate chapter on the ammonia spectrum and related problems. Four further chapters (110 pp.) treat experimental methods and instruments and a final chapter deals with applications to chemical analysis."

535.33.03

2773. SPECTRA OF COOL FLAMES AND PRE-IGNITION GLOWS. A.G.Gaydon and N.P.W.Moore.
Proc. Roy. Soc. A, Vol. 233, 184-94 (Dec. 20, 1955).

Cool flames and pre-ignition glows of rich and weak mixtures of propane with air and oxygen have been studied in a simple flow system at atmospheric pressure. In the cool-flame region the spectrum shows the usual formaldehyde emission bands, but in the pre-ignition glow near the high-temperature ignition limit the spectrum is quite different, consisting mainly of hydrocarbon flame bands, due to HCO. With weak mixtures the HCO bands are accompanied by strong OH and some CH and CO-flame bands and the spectrum is rather similar to that of the hot flame. With rich mixtures, the HCO bands are accompanied by some CH and formaldehyde bands and weak OH but no C_2, so that the spectrum is quite different from that of the rich hot flame, which is dominated by C_2 and CH emission and shows little HCO. The unusual observation of strong HCO with rich mixtures is discussed. It is suggested that the C_2 and CH emission occurs under conditions when free atoms and radicals diffuse back from the burnt mixture, while the HCO emission is associated with chain termination or thermal initiation processes. This supports the view that radical diffusion is important in flame propagation. No pre-ignition glow was observed with methane or formaldehyde. The pre-ignition glow of CO occurs readily at both rich and weak limits at atmospheric and low pressure and shows CO-flame bands (attributed to CO_2). Addition of methane or formaldehyde to the CO modifies the ignition limits and reduces the glow region, but with a little methane added to rich CO + O_2, clear spectra were obtained which showed the cool flame bands of formaldehyde superposed on the CO-flame bands. Addition of formaldehyde instead of methane did not produce the formaldehyde bands. The reaction processes are discussed, and it is suggested that during oxidation of CO, free O atoms or O_3 are produced which may react with methane to result in cool flame processes. The relation of these observations to previous work on the auto-ignition of methane is discussed. A.

535.33.07

2774. PULSE COUNTING PHOTOMETER FOR MICROSPECTROSCOPY. W.Thornburg.
Rev. sci. Instrum., Vol. 27, No. 2, 99-102 (Feb., 1956).

A photometer for recording the absorption spectra of microscopic samples in the visible and ultraviolet regions is described. Light intensities are measured by counting the pulse output of a cooled photomultiplier tube. Double-beam operation is achieved through the use of a rotary shutter and a gating circuit which sorts the beams into separate scaling channels. Optimum signal-to-noise levels are obtained by pulse-height discrimination. In typical operation the noise level is approximately 20 photoelectrons per minute, the signal level at 100% transmission is approximately 20 000 photoelectrons per minute, and approximately 50 absorption points are recorded per

hour at an accuracy of ± 1%. The system minimizes the errors which result from fluctuations in light source intensity, amplifier drift, and variations in photomultiplier plate voltage so that accuracies of ± 0.1% can be achieved with the photometer (but not with the microspectrometer). With appropriate correction for noise and resolving time the system can be operated over four decades of light intensity. Application of this type of photometer to other spectrographic problems is suggested and representative data are presented. A.

535.33.07 : 535.417

2775. INTERFEROMETRIC FREQUENCY CALIBRATION OF INFRARED SPECTROMETERS. S.Brodersen.
J. Opt. Soc. Amer., Vol. 46, No. 4, 255-8 (April, 1956).

The theory of certain errors involved in interferometric frequency calibration is developed. The origins of these errors are (1) the effective slit width of the monochromator and (2) the height of the slit. For uncoated, low reflecting interferometer plates a complete theory is given. For higher reflecting plates the effect of the slit height has been calculated in detail for one definite choice of reflection coefficient. The results of this calculation are thought to be representative also for other cases. The main effect both of the slit width and the slit height is a blurring of the interference pattern. But moreover the maxima are displaced on account of the slit height effect. This may cause serious errors in calibrations. Curves are presented, giving the "fractional order" of the maxima for different cases. A.

535.332

2776. THE TERM $1s^2 2s2p3s\ ^4P^0$ IN THE FIRST SPECTRUM OF BORON. E.W.Burke, Jr and J.E.Mack.
J. Opt. Soc. Amer., Vol. 46, No. 2, 100 (Feb., 1956).

The following levels have been identified in B I: $1s^2 2s2p3s\ ^4P_{1/2}{}^0$ at 77 168 + x; $^4P_{3/2}{}^0$ at 77 175 + x; $^4P_{5/2}{}^0$ at 77 187 + x cm^{-1}. A.

535.337

2777. ZEEMAN EFFECT OF SOME LINEAR AND SYMMETRIC-TOP MOLECULES. J.T.Cox and W.Gordy.
Phys. Rev., Vol. 101, No. 4, 1298-1300 (Feb. 15, 1956).

The Zeeman effect in the microwave rotational spectra of some linear molecules and symmetric top molecules has been investigated. The rotational g factors obtained are in nuclear magnetons: $|g| = 0.0295 \pm 0.005$ for OCS; $|g| = 0.268 \pm 0.005$ for CO. In the symmetric-top molecules the components of the rotational g factor along the symmetry axis, g_K, and perpendicular to this axis, $g_\perp$, were measured as follows: $|g_\perp| = 0.0624 \pm 0.005$ and $(g_\perp - g_K) = 0.549$ for CH_3F; $|g_\perp| = 0.03$ for CF_3H; $g_\perp \simeq 0$ and $g_K = 0.298 \pm 0.006$ for CH_3CCH; $g_\perp \simeq 0$ and $g_K = 0.31 \pm 0.01$ for CH_3CCD; $|g_\perp| = 0.065 \pm 0.01$ for PF_3; $|g_\perp| = 0.03$ for POF_3. The rotational g factor for OCS was measured with several different transitions up to $J = 13 \rightarrow 14$ and was found to be a constant, independent of J within the accuracy of the measurements. A.

535.338.332 : 535.338.334

2778. THE MEASUREMENT OF SPECTRAL (LINE) STRUCTURES FROM OBSERVATIONS OF INTERFERENCE CONTRAST. W.Weizel and G.Meister.
Z. Phys., Vol. 144, No. 1-3, 177-96 (1956). In German.

Describes an interferometric method for the determination of fine structure and line widths (for symmetrical broadening), using a technique involving variable path differences. Various examples are given, and the interference patterns are shown for the Na D lines, Hg 5460 A, Zn 4810 A and others, so that the effect of varying fine structure is demonstrated. Some of the lines were excited in arc discharges, to the study of which the present method is applicable. J.D.Craggs

535.338.333

2779. ISOTOPE SHIFT IN THE NdII SPECTRUM. G.Nöldeke.
Z. Phys., Vol. 143, No. 3, 274-84 (1955). In German.

The hyperfine structure between 4000 and 6500 A is studied with a Fabry–Perot interferometer. The isotope-shift constants are evaluated from the spectrum and compared with those of corresponding Sm isotopes. The spectral lines are compared with those of NdI. G.E.Brown

535.34 : 548.55

DIRECT PRODUCTION OF SPECTROSCOPIC SPECIMENS FROM SINGLE CRYSTALS BY CONTROLLED GROWTH FROM A VAPOR. See Abstr. 2535

535.343 : 539.132

2780. ADVANCES IN MOLECULAR SPECTROSCOPY. H.W.Thompson.
Nature (London), Vol. 176, 680-3 (Oct. 8, 1955).

Brief report of a meeting of the European Molecular Spectroscopy Group, held at Oxford, July 7-11 (1955).

535.343 : 539.132

ABSORPTION BANDS OF CARBON MONOXIDE. See Abstr. 2287

535.343

2781. ABSORPTION BANDS OF RUBIDIUM DUE TO THE PRESENCE OF FOREIGN GASES. Shang Yi Ch'en, R.B.Bennett and O.Jefimenko.
J. Opt. Soc. Amer., Vol. 46, No. 3, 182-6 (March, 1956).

In the presence of heavy foreign gases, such as Kr and Xe, diffused absorption bands were observed at both the short wavelength and the long wavelength side of the first four absorption doublets of the Rb principal series. The red bands were observable when the Rb vapour pressure in the absorption tube was relatively low (10^{-3} to 10^{-2} mm Hg). The violet bands were not intense enough until the Rb vapour pressure was increased to 0.1 - 1 mm Hg. With other lighter gases (H_2, He, Ne, A, N_2) only violet bands were observed. The positions and the absorption contours of the bands in relation to the member of the absorption series and to the nature of the foreign gases are discussed. A.

535.343

2782. THE 7500 TO 4500 A ABSORPTION SYSTEM OF THE FREE HCO RADICAL. G.Herzberg and D.A.Ramsay.
Proc. Roy. Soc. A, Vol. 233, 34-54 (Dec. 6, 1955).

A fairly extensive absorption spectrum of the free HCO radical produced by flash photolysis of acetaldehyde and other substances has been investigated with long absorbing paths and under high resolution. The corresponding DCO spectrum has also been studied. The absorption spectrum consists of simple bands with P, Q and R branches. It is shown that the molecule is linear in the upper state, but bent in the lower state with an angle of about 120° and a CO bond length of approximately 1.20 A. Rotational constants of HCO and DCO in both upper and lower states have been derived. Various arguments based on the high-resolution measurements lead to the conclusion that the main progression of bands corresponds to transitions to the vibrational levels of the upper state with even v_2' (the vibrational quantum number of the bending mode). This conclusion is confirmed by the observation under low dispersion of some of the intermediate bands with odd v_2' which are diffuse and therefore not easily recognizable under high resolution. Apparently all levels of the upper state with $l \neq 0$ are predissociated. The type of the electronic transition is shown to be $^2\Sigma^+ \leftarrow {}^2A''$, that is, the transition moment is perpendicular to the molecular plane. The lower state cannot arise from normal CO and H. A.

535.343

2783. INFRARED SPECTRA OF GASEOUS HEXACHLORODISILANE Y.Morino.
J. chem. Phys., Vol. 24, No. 1, 164 (Jan., 1956).

Measurements on the infrared and Raman (on the liquid) spectra confirm the electron diffraction evidence (Abstr. 8978/1955) that the configuration of this molecule does not remain fixed at the staggered position. G.I.W.Llewelyn

535.345

2784. ABSORPTION OF LIGHT BY ATOMS IN SOLIDS. D.L.Dexter.
Phys. Rev., Vol. 101, No. 1, 48-55 (Jan. 1, 1956).

The interactions of an atom with its neighbours in an idealized solid are taken into account explicitly in treating the absorption of light, as contrasted with the usual introduction of an "effective" field and mass. In the discussion of the magnitude of the absorption coefficient, two cases are treated: one, the absorption by an impurity atom, which case leads to an equation similar to Smakula's; and two, the absorption by one of the atoms of the perfect crystal. The computations are based on a simple idealized model whose validity is discussed for existing systems. A.

535.345

2785. INFRARED ABSORPTION AND OXYGEN CONTENT IN SILICON AND GERMANIUM. W.Kaiser, P.H.Keck and C.F.Lange.
Phys. Rev., Vol. 101, No. 4, 1264-8 (Feb. 15, 1956).

An optical absorption band at 9μ has been correlated with the oxygen content in silicon. Pulled silicon crystals were found to contain up to 10^{18} oxygen atoms per cm^3 which seem to originate from the quartz crucible. The oxygen concentration in silicon crystals prepared by the floating zone technique in vacuum was found to be less than 10^{16} oxygen atoms per cm^3. The 9μ absorption due to silicon-oxygen bond stretching vibrations provides a possibility for a quantitative oxygen analysis of high sensitivity. A corresponding absorption in germanium at 11.6μ is believed to be due to a germanium-oxygen vibration. A.

535.345 : 535.42

2786. DAMPING AND DIFFRACTION PROPERTIES OF A THICK METAL SLIT. I. D.Heinze and C.Schmelzer.
Z. Phys., Vol. 142, No. 2, 133-44 (1955). In German.

Light polarized with its electric vector parallel (E$\parallel$) or perpendicular (E$\perp$) to the length of the slit is incident on a nickel slit of width 2-10 microns and wall thickness 2-10 mm. This forms the entrance slit of a spectrograph and by normal photographic photometry the transmission (or damping) of the slit is measured through the visible spectrum. The damping is greater for E$\perp$. Diffraction patterns are photographed for E$\parallel$ and E$\perp$ for incident light making angles to the plane of the slit walls up to 2½°. The patterns consist of 1 or 2 maxima and are compared with those from microwaves under similar circumstances. G.F.Lothian

535.345 : 535.42

2787. DAMPING AND DIFFRACTION PROPERTIES OF A THICK METAL SLIT. II. D.Heinze and C.Schmelzer.
Z. Phys., Vol. 142, No. 2, 145-60 (1955). In German.

Transmission through a thick slit with walls of finite conductivity is calculated by exact solution of the Maxwell equations. After inserting the optical constants of Ni into the results it is possible to plot the damping constant against wavelength; the curves agree well with the measurements of Pt I. G.F.Lothian

535.347 : 548.7

2788. DICHROISM OF THE F AND M ABSORPTION BANDS IN KCl. C.Z.van Doorn and Y.Haven.
Phys. Rev., Vol. 100, No. 2, 753 (Oct. 15, 1955).

F-band irradiation of KCl at 77° K for a few minutes in the 100 direction with light polarized in the 011 direction gives increased M-band absorption for light polarized in the 011 direction. There is a corresponding decrease in absorption for light polarized in 0$\bar{1}$1 direction. Dichroism then persists in the dark at 77° K for several hours but disappears on warming to 200° K. M-centres are assumed therefore to be anisotropic and the F- and M-bands to be due to the same centre. G.F.J.Garlick

535.347 : 548.7

2789. THE PROPAGATION OF LIGHT IN ABSORBING BIAXIAL CRYSTALS. II. EXPERIMENTAL. S.Pancharatnam.
Proc. Indian Acad. Sci. A, Vol. 42, No. 5, 235-48 (Nov., 1955).

For Pt I, see Abstr. 9574 (1955). The phenomena shown in convergent light by a section plate of iolite cut normal to an optic axis are discussed and illustrated. Of particular interest among the photographs reproduced are those taken (a) between circular polarizer and crossed circular analyser, demonstrating the existence of the two singular axes (a right-circular vibration alone being propagated unchanged along one singular axis, and a left-circular vibration alone along the other); (b) with a circular polarizer alone, confirming the theoretical prediction in Pt I that the singular axis where the incident circular vibration can be propagated unchanged should appear darker than the other; the state of the elliptic vibration emerging from the brighter singular axis was also qualitatively in accord with theory. Examination between elliptic polarizer and crossed elliptic analyser demonstrated that along any general direction in an (optically inactive) absorbing biaxial crystal, two similarly rotating elliptic vibrations can be propagated unchanged — the major axes being crossed but not coincident with the principal planes of refraction. A.

535.361.2

2790. NARROW PASS BAND ALBEDOMETER. E.V.Ashburn, C.P.Pentoney, Z.W.Hohanshelt and R.G.Weldon.
Rev. sci Instrum., Vol. 27, No. 2, 90-1 (Feb., 1956).

An albedometer is described that has the incident radiations entering an integrating sphere instead of falling directly upon a horizontal receiver, as in the albedometers that have been used in the past. In this new albedometer the receiver looks at a small opal glass window in the sphere. Filters with a narrow pass band may be placed between the window and the receiver. This arrangement makes it possible to determine the variation of albedo with wavelength. A.

535.371

2791. MAGNESIUM FLUOROSILICATE PHOSPHORS. P.W.Ranby and S.T.Henderson.
J. Electrochem. Soc., Vol. 102, No. 11, 631-5 (Nov., 1955).

The preparation of phosphors with a matrix of magnesium, silicon, oxygen, and fluorine, and activated by titanium or titanium and manganese is described. X-ray data are given. The materials when excited by mercury resonance radiation have wide emission bands with a high proportion in the long-wavelength region of the spectrum. They are useful fluorescent lamp phosphors. The mechanism of the luminescence appears to be sensitization by titanium, although there are unusual features in the case. A

535.371

2792. THE PHYSICAL CHEMISTRY OF CRYSTAL PHOSPHORS. F.A.Kröger.
Proc. Inst. Radio Engrs, Vol. 43, No. 12, 1941-4 (Dec., 1955).

After a historical introduction, a survey is given of the present views regarding the constitution and the preparation of inorganic crystal phosphors. Particular attention is paid to the incorporation of atoms with a valency deviating from that of the atoms of the base material, and to the stabilization of atoms in a particular valency. A.

535.371

2793. LEAD- AND MANGANESE-ACTIVATED CADMIUM FLUOROPHOSPHATE PHOSPHORS. R.W.Wollentin.
J. Electrochem. Soc., Vol. 103, No. 1, 17-23 (Jan., 1956).

The characteristics of lead- and manganese-activated cadmium fluorophosphates and homologous materials containing aluminium, barium, calcium, strontium, magnesium, zinc, sodium and potassium as partial replacements for cadmium are described. With low activator concentrations in cadmium fluorophosphate, a double band emission is obtained with peaks at 4500 A and 5900 A. At high activator concentrations the blue peak is suppressed. The luminous output and spectral emission of the mixed phosphors are dependent upon activator concentration, the amount of halide relative to the cadmium phosphate portion of the phosphor, the amount of phosphorus relative to cadmium, and the cation which replaces cadmium. Substitutions of sodium, potassium and zinc for cadmium shift the emission and excitation spectra toward longer wavelengths. The X-ray patterns of these phosphors are quite complex and vary from sample to sample. However, they are all similar to an apatite configuration with the exception of the alkali modified phosphors which display quite different and unidentified patterns. In the case of the double band emission of the unmodified phosphor, the yellow band is suppressed at low temperatures and phosphorescence is enhanced. Above room temperature the fluorescence and phosphorescence of all the phosphors are decreased almost to extinction at 150° C. A.

535.371

2794. MAGNETIC EFFECTS IN PHOSPHORS UNDER ILLUMINATION. W.D.Hershberger.
J. chem. Phys., Vol. 24, No. 1, 168-9 (Jan., 1956).

It is suggested from experimental data that the effects in zinc sulphide, zinc silicate, zinc aluminate, magnesium titanate and zinc fluoride phosphors on u.v. excitation are due to photoconduction as they are independent of magnetic field. This gives added support for luminescence as due to changes in multiplicity of the Mn^{2+} ions by 3d shell transitions. G.F.J.Garlick

535.371 : 539.185.9

2795. EFFECT OF NEUTRON BOMBARDMENT ON A ZINC SULFIDE PHOSPHOR. A.W.Smith.
Phys. Rev., Vol. 101, No. 4, 1263 (Feb. 15, 1956).

It was previously shown that neutron bombardment produced new traps in a zinc sulphide phosphor. These were interpreted as electron traps on the model of Klasen and Schoen. The new model proposed by Lambe and Klick for cadmium sulphide may be used. This new model gives a better interpretation of the dielectric constant changes observed on neutron-irradiated samples, and is consistent with the rest of the data. A.

535.372

2796. VIBRATIONAL STRUCTURE OF PHOSPHORESCENCE SPECTRA OF AROMATIC CRYSTALS AT VERY LOW TEMPERATURES. P.Pesteil and A.Zmerli.
Ann. Phys. (Paris), Vol. 10, 1079-97 (Nov.-Dec., 1955). In French.

Crystals of aromatic compounds show luminescence spectra at 20° K with well resolved fine structure. Interpretation of the spectra of benzene, xylene, hexachlorobenzene etc. are given. An explanation of photoconductivity in such materials is given in terms of the close lying triplet and singlet states of the molecules. G.F.J.Garlick

535.375.5

2797. RAMAN SPECTRUM OF THE HYDRONIUM ION. J.T.Mullhaupt and D.F.Hornig.
J. chem. Phys., Vol. 24, No. 1, 169 (Jan., 1956).

The Raman spectrum of single crystals of OH_3ClO_4 was observed in the range 300-3700 cm^{-1}. A broad diffuse band between 2460 and 3600 cm^{-1} is thought to be the OH stretching band of the OH_3^+ ion. Correlation with infrared spectra results confirms this. G.I.W.Llewelyn

535.375.54

2798. ON CERTAIN ANOMALIES OF THE RAMAN EFFECT IN CRYSTALS. H.Poulet.
Ann. Phys. (Paris), Vol. 10, 908-67 (Nov.-Dec., 1955). In French.

Two types of spectral anomalies are considered. (i) Spectra of cubic piezoelectric crystals which contain supernumerary lines where the values of the depolarization factors are such that they may not be classified into any type of symmetry proposed by theory, e.g., the spectra of $NaClO_3$ and of $NaBrO_3$. (ii) Variations in the frequency of certain lines in the spectra of uniaxial or biaxial piezoelectric crystals are observed on altering the orientation of the crystal in the apparatus. Anomalies in the depolarization factor and in the spectral intensity are also observed here, e.g., the spectra of $LiClO_4.3H_2O$ and HIO_3. A theory to explain these anomalies is proposed, based on the action of the polarization field produced by movement of electrical charges. G.I.W.Llewelyn

535.375.54

2799. RAMAN SPECTRUM OF THE WATER OF CRYSTALLIZATION OF LITHIUM SULPHATE MONOHYDRATE $Li_2SO_4.H_2O$ AT LOW TEMPERATURE. A.Weill-Marchand.
C.R. Acad. Sci. (Paris), Vol. 242, No. 1, 93-5 (Jan. 4, 1956). In French.

Measurements have been made at − 120° C on a monocrystal. The differences between these results and those obtained at +20° C (Abstr. 2326/1954) are attributed to alteration in the orientation of the water molecule. G.I.W.Llewelyn

535.375.54 : 535.371

2800. RAMAN SPECTRA AND FLUORESCENCE OF A FEW SUBSTITUTED TOLUENES IN THE SOLID STATE AT DIFFERENT LOW TEMPERATURES. D.C.Biswas.
Indian J. Phys., Vol. 29, No. 6, 257-71 (June, 1955).

The Raman spectra of m-$CH_3C_6H_4Cl$, m-$CH_3C_6H_4Br$ and o-, m- and p-$CH_3C_6H_4OH$ in the liquid state and in the solid state at different temperatures were studied. Each of the liquids has yielded a few new feeble lines not reported by previous workers. It is found that except in the case of p-cresol, a strong line in the neighbourhood of 200 cm^{-1} disappears in each case when the liquid is solidified. An explanation has been offered for this change. Similar to the case of other substituted benzenes, a few Raman lines appear in the low-frequency region when the substances are solidified. Changes in the frequency-shifts, as well as in the intensities of these new lines, are observed on lowering the temperature of the crystals to −180° C. An attempt has been made to interpret these results. A.

535.376

2801. THE ENHANCEMENT EFFECT OF ELECTRIC FIELDS ON SOME X-RAY EXCITED PHOSPHORS. G.Destriau, J.Mattler, M.Destriau and H.E.Gumlich.
J. Electrochem. Soc., Vol. 102, No. 12, 682-4 (Dec., 1955).

Further experiments are reported on the enhancement of phosphor output by the application of an electric field. This new and permanent enhancement of the light emitted by phosphors irradiated by X-rays is different from the momentary illumination observed in the Gudden and Pohl effect. Many factors have been studied, such as field strength, frequency, and temperature. A.

535.376

2802. CATHODOLUMINESCENCE. G.F.J.Garlick.
Proc. Inst. Radio Engrs, Vol. 43, No. 12, 1907-11 (Dec., 1955).

A review of recent advances in fundamental knowledge of the mechanism of luminescence excitation by electrons is given. The development of the scintillation counter and studies of electron scattering together with progress in the study of photoluminescence mechanisms in phosphors have provided a new basis for establishing a sound theory of cathodolumines-

cence. It is shown that the brightness–voltage relations for conventional screens result from the complex microcrystalline form of the phosphor. Single-crystal studies with electron beam and single-particle excitation reveal a more simple behaviour. Ultimate screen efficiency is shown to be strongly dependent on loss of scattered primary and secondary electrons from the phosphor surface and on nonradiative electron–hole recombination in electron traps and other nonluminescent centres. Current saturation and electron burn are also discussed. A.

535.376

2803. ELECTROLUMINESCENCE AND RELATED TOPICS. G.Destriau and H.F.Ivey.
Proc. Inst. Radio Engrs, Vol. 43, No. 12, 1911-40 (Dec., 1955).

Light may be generated by the direct action of an electric field on various solid materials by a number of different mechanisms (electroluminescence). Electric fields may also influence luminescence phenomena excited by various types of radiation (electrophotoluminescence). The varied phenomena which have been observed, and their dependence on the operating parameters, are reviewed and theoretical explanations are given where possible. Possible practical applications of electroluminescence and electrophotoluminescence are also discussed. 162 refs. A.

535.376

2804. TIME-AVERAGE ELECTROLUMINESCENCE OUTPUT OF SOME ZINC SULFIDE PHOSPHORS. S.Nudelman and F.Matossi.
J. Electrochem. Soc., Vol. 103, No. 1, 34-8 (Jan., 1956).

Dependence of time-average electroluminescence output on field strength and frequency is observed for frequencies up to 20 kc/s for green and blue emission. The field dependence can be described either by a power law or by an exponential law. The frequency dependence is discussed in terms of theoretical relations connecting the light output to recombination characteristics or to polarization effects. The polarization effects are of minor importance. Light outputs from sinusoidal and square-wave excitation are compared. A.

535.376 : 537.312.5 : 621.383

2805. OPTO-ELECTRONIC DEVICES AND NETWORKS. E.E.Loebner.
Proc. Inst. Radio Engrs, Vol. 43, No. 12, 1897-906 (Dec., 1955).

The transducing properties of electroluminescent and photo-responsive cells are described. The light amplifying and spectrum-converting characteristics of a circuit consisting of an electric power supply and a series combination of the two types of cells whose impedances have been matched are discussed. The construction and operation of an opto-electronic bistable device — the "optron" — employing positive radiation feedback, is reported. The optron is both a storage cell and a switch with dual (optical and electrical) signal input and output. Numerous logic networks, composed of electric series and parallel combinations of electroluminescent and photoconductive cells with selected optical couplings have been designed, constructed, and operated. 23 refs. A.

535.377

2806. THERMOLUMINESCENCE PROPERTIES OF SOME ALKALI HALIDES. J.Sharma.
Phys. Rev., Vol. 101, No. 4, 1295-7 (Feb. 15, 1956).

Thermoluminescence curves of KI, KI : Tl, NaBr : Tl, KBr : Tl, NaI, NaF, and LiCl have been recorded after exciting the samples with low-energy cathode rays at liquid oxygen temperature. By using suitable filters and photomultiplier tubes, the thermoluminescence was recorded for different spectral regions and it was found that the high-temperature peaks are rich in ultraviolet emissions. The dependence of thermoluminescence on thermal treatment of the sample has been studied for KI. The changes in the absorption bands of some of the colour centres, during thermoluminescence, have been investigated by simultaneously measuring diffuse reflectance. It has been found that glow peaks are accompanied by changes in colour centres. A.

535.39

2807. ON THE DETERMINATION OF THE OPTICAL CONSTANTS n, κ FROM REFLECTION MEASUREMENTS. N.Neuroth.
Z. Phys., Vol. 144, No. 1-3, 85-90 (1956). In German.

The theory and precision of such measurements are discussed. New data covering a spectral range between 7 and 12 microns were obtained for quartz at temperatures lying between 18 and 1270°C, and for glass. R.A.Weale

535.39

2808. OPTICAL PROPERTIES OF INDIUM ANTIMONIDE IN THE REGION FROM 20 TO 200 MICRONS. H.Yoshinaga and R.A.Oetjen.
Phys. Rev., Vol. 101, No. 2, 526-31 (Jan. 15, 1956).

The reflectivity and the transmission of InSb crystals (n-type) were measured between 20 and 200 microns. The reflectivity curve has a sharp maximum at 54.6 microns and the transmission curve shows a low transmission at the same wavelength due to lattice vibration of this crystal. The transmission curve shows a weak absorption at 28.3 microns due to the overtone of that lattice vibration. The reflectivity curve shows another flat peak at longer wavelengths. The reflectivity minimum between these two peaks shifts from 160 to 72 microns with increase of temperature from −35 to 130°C, and the maximum value of the flat peak increases with increase of temperature and is 80% at temperatures of 100° C or more. The index of refraction n and the absorption constant K were calculated in the region in which both the reflectivity and the transmission were measured. Using the values of n and K thus obtained, the concentration of free electrons N and their mobility b were obtained, using the theory of free electrons. Then n, K, and the reflectivity, R, were calculated for the region in which the transmission could not be measured. The values of R thus obtained agree well with the observed values. This shows that the theory of free electrons holds in InSb except in the region in which the effects of lattice vibration in this crystal are dominant. A.

535.39

2809. REFLECTION-REDUCING COATINGS OF MAGNESIUM FLUORIDE AND LITHIUM FLUORIDE IN THE NEAR INFRARED. J.R.Jenness, Jr.
J. Opt. Soc. Amer., Vol. 46, No. 3, 157-9 (March, 1956).

A brief derivation of formulae for the transmittance of flat plates, uncoated and coated, is presented. Data showing the increased near infrared transmittance of seven flat samples resulting from quarter-wave coatings of MgF_2 and LiF on their surfaces is presented. Five were coated to maximize transmittance for a wavelength of 2 microns, and two had coatings to maximize transmittance at 3.6 microns wavelength. Thick coatings of MgF_2 do not adhere well. The coatings had absorption bands, possibly due to H_2O. Estimates are made of the refractive indices of MgF_2 and synthetic sapphire in the near infrared. A.

535.39

2810. REFLECTANCE OF GOLDBLACK DEPOSITS, AND SOME OTHER MATERIALS OF LOW REFLECTANCE FROM 254 mμ TO 1100 mμ. THE SCATTERING-UNIT-SIZE IN GOLDBLACK DEPOSITS. L.Harris and K.F.Cuff.
J. Opt. Soc. Amer., Vol. 46, No. 3, 160-3 (March, 1956).

The total reflectances for the spectral region 254 mμ to 1100 mμ of goldblack deposits and several other low-reflecting materials have been determined from the angular distribution of the reflectance. Reflectances in the visible spectrum were also obtained using an integrating sphere. All substances

examined, except optical-black-lacquer, were found to have immeasurable specular reflectance at all the wavelengths measured. These measurements together with long wavelength reflectance measurements of goldblack deposits indicate that such deposits contain a relatively large number of scattering units between about 0.2 micron and 8 micron. Additional measurements, presented here, including the angular distribution of the forward scattering in the visible spectrum, give results in agreement with the above. A.

535.417

2811. THE MEASUREMENT OF THE COHERENCE OF A LIGHT WAVE BY MEANS OF A LLOYD MIRROR. A.H.McIlraith.
Proc. Phys. Soc. B, Vol. 68, Pt 12, 1148-50 (Dec. 1, 1955).

The coherence of a wave front can be calculated from the fringe visibility in a Young's interference experiment. The Lloyd mirror is recommended as an alternative since it gives more intense fringes, is easier to make than the Young slits, and gives in one photograph as much information as a complete series of Young experiments. R.W.Fish

535.417

2812. BROAD-BAND MULTILAYER FILM FOR FABRY–PEROT INTERFEROMETERS. P.W.Baumeister and J.M.Stone.
J. Opt. Soc. Amer., Vol. 46, No. 3, 228-9 (March, 1956).

Quarter-wave multilayers of alternate zinc sulphide and cryolite have a fairly narrow region of high reflectivity. The range of high reflectivity (exceeding 0.93) has been considerably extended (exceeding 0.90 from about 4000 to 7200 A). This is secured with a complex multilayer of 15 films all of different thickness. The optimum thicknesses required have been computed with a high speed electronic computing machine. The experimentally produced films are fairly close to those theoretically predicted. S.Tolansky

535.417 : 534.152

2813. MULTIPLE-BEAM INTERFEROMETRIC METHOD OF STUDYING SMALL VIBRATIONS. B.S.Thornton and J.C.Kelly.
J. Opt. Soc. Amer., Vol. 46, No. 3, 191-4 (March, 1956).

A method of calibrating sensitive vibrometers using a multiple beam interferometric and stroboscopic technique has been described by Bruce, Macinante, and Kelly (Abstr. 5505/1954). This paper describes an alternative multiple-beam method of measuring very small vibrations, which does not require stroboscopic techniques and is the multiple-beam analogue of Osterberg's two-beam method. A.

535.42 : 536.2 : 538.566

2814. APPLICATIONS OF THE FOURIER INTEGRAL IN PHYSICAL SCIENCE. C.H.Page.
I.R.E. Trans Circuit Theory, Vol. CT-2, No. 3, 231-7 (Sept. 1955).

"Physical" philosophy of Fourier transform approach is presented, and formalism discussed in 1-, 2- and 3-dimensional problems. Applications is made to the dissipative wave equation in three dimensions, and the responses are found for (1) distributed driving force, (2) relaxation from initial conditions, and (3) time-varying boundary conditions. One-dimensional heat-flow problems are also discussed. A.

535.515

2815. MEASUREMENT OF BIREFRINGENCE. M.G.Dreyfus.
J. Opt. Soc. Amer., Vol. 46, No. 2, 142 (Feb., 1956).

A method for a rough but rapid determination of the birefringence δ due to a doubly-refracting material is described. The brightness B_1 produced when this material is inserted between a crossed polarizer and analyzer is compared with the value B_2 obtained when the material is replaced by another polarizing device. The azimuth of the latter for which B_1 equals B_2 is shown to be simply related to δ. H.G.Jerrard

535.515

2816. DETERMINATION OF EXTINCTION DIRECTIONS IN A DOUBLY-REFRACTING MEDIUM OF SMALL PHASE DIFFERENCE: APPLICATION TO FLOW BIREFRINGENCE STUDIES. H.G.Jerrard.
J. Opt. Soc. Amer., Vol. 46, No. 4, 259-62 (April, 1956).

Extinction directions in a medium M may be found by using a polarizer P, a Nakamura half-shade H, and an analyser A. These components are set up with P and A crossed and so that monochromatic light passes in turn through P, M, H, and A to enter a microscope focused on the dividing line of H. The extinction directions are found by rotating M until the field of view is of uniform brightness: they coincide then with the vibration directions of P and A. This method is considered in detail, and it is shown on theoretical grounds that, for media having a phase difference less than $\pi/2$, increased sensitivity results when a quarter-wave plate Q is inserted, in zero azimuth with respect to the vibration direction of P, between M and H. The calculated increase for very small phase differences is considerable: experiment confirms this. A comparison is made with a method in which H is a half-shade of the Bravais type and Q is omitted. The present arrangement serves also as a sensitive compensator for the measurement of optical phase differences and it is, therefore, particularly suitable for measurements, such as occur in flow birefringence studies, where both extinction angles and the magnitude of the birefringence are required. This application is discussed. A.

535.515

2817. DISPERSION OF BIREFRINGENCE OF QUARTZ IN THE NEAR INFRARED. J.H.Shields and J.W.Ellis.
J. Opt. Soc. Amer., Vol. 46, No. 4, 263-5 (April, 1956).

Direct experimental determinations of the birefringences of quartz in the 0.6-2.6μ region were made by means of channeled spectra. Up to 2.0μ, the experimentally determined birefringences of quartz were found to agree within experimental error with values obtained by subtracting from each other independently measured refractive indices, n_o and n_e, as listed in the International Critical Tables. Beyond 2.0μ, the experimentally determined birefringences gradually became appreciably smaller than the corresponding $(n_e - n_o)$ values. The variation appears to be associated with the moderately strong absorption band of quartz which occurs at about 3.0μ, and suggests the possible existence of two sets of birefringence values near such a band. A.

535.65

2818. RAUTIAN ON COLOR DISCRIMINATION. D.L.MacAdam.
J. Opt. Soc. Amer., Vol. 45, No. 12, 1065-71 (Dec., 1955).

Ellipses representing just-perceptible differences of colour from 36 basic colours have been published by G.N.Rautian (1949-53). These constitute the first redeterminations of colour-discrimination ellipses. Unfortunately, Rautian published his results in an obscure coordinate system. Therefore, Rautian's results have been converted to the C.I.E. chromaticity diagram to facilitate their comparison with previous results. In general, the just-perceptibly different colours determined by Rautian were not equiluminous. Adjustments were therefore made, corresponding to the contributions of the subliminal luminance differences to the perceptibility of the measured colour differences, so as to render Rautian's results directly comparable with results obtained with equiluminous colours. Important differences are revealed. Rautian's ellipses are of almost constant size throughout the C.I.E. chromaticity diagram. On the other hand, their shapes and orientations agree well with previously published ellipses. Later results published by Rautian and Solov'eva generally confirm previously reported effects of surround luminance and colour on chromaticity discrimination. Furthermore, these later results of Rautian and Solov'eva generally confirm the variation of sizes as well as the shapes of discrimination ellipses reported by other workers. A.

535.66

2819. COLORS OF NATURAL OBJECTS. R.Penndorf.
J. Opt. Soc. Amer., Vol. 46, No. 3, 180-2 (March, 1956).

The spectral reflectance of natural objects is taken from Krinov's measurements. Based on these data, the colour parameters are computed for these objects. It is shown that most natural objects possess a dominant wavelength between 5700 A and 5900 A, i.e. in the greenish yellow part of the spectrum. Even for vegetative formations, as seen from a distance, the dominant wavelength is also in the greenish yellow spectral range, which is a surprising fact because one would expect a dominant green. This colour is, however, a mixture of brown and green. The excitation purity of bare areas and soils is low (15-30%), but it is higher for vegatative formations (25-50%). Vertical formations such as forests seen from directly above, reflect only a very small amount (2-3%) of the light which falls upon them from the sun and sky, but as seen from the ground their reflectance is much higher (about 8%). A.

535.7

PHYSIOLOGICAL OPTICS. VISION. See under "Medical science. Human physiology". Decimal classification 612.84

535.83 : 771.351

2820. NEW SERIES OF DISTORTIONLESS TELEPHOTO LENSES. T.Kazamaki and F.Kondo.
J. Opt. Soc. Amer., Vol. 46, No. 1, 22-31 (Jan., 1956).

Discusses the pros and cons of telephoto lenses of old types and a series of improved old types, showing several examples of these. A description is given of a series of newly-designed distortionless telephoto lenses consisting of five types with apertures of 1/4.5 to 1/2.8 and covering an angle of approximately 25°. A.

535.88

2821. ANISOTROPIC PROJECTOR. R.B.Leighton.
Rev. sci. Instrum., Vol. 27, No. 2, 79-82 (Feb., 1956).

An optical projector having different magnifications, 5 x and 50 x, in two rectangular directions is described. Although the device is designed principally for rapid measurement of cloud-chamber track curvatures, it has been applied to various situations in which plane-to-plane imaging at constant magnification is desired. Simple plano-convex cylindrical lenses are used as the image-forming elements. These give quite satisfactory linearity and resolution at the maximum magnification. A.

535.89

2822. HIGH-SPEED LIGHT PULSE SHAPER USING A 5000 RPS ROTATING MIRROR. J.B.Cladis, C.S.Jones and K.A.Wickersheim.
Rev. sci. Instrum., Vol. 27, No. 2, 83-7 (Feb., 1956).

A light pulse generator is described which utilizes a flash lamp and a 5000 revolutions per second rotating mirror. A variety of light pulse shapes can be produced having widths from 1.16×10^{-9} sec to 10^{-6} sec. A.

HEAT 536

536.2.08

2823. FITCH'S THERMAL CONDUCTIVITY APPARATUS. C.Williamson.
Amer. J. Phys., Vol. 23, No. 7, 471 (Oct., 1955).

Worthing has pointed out that air films can cause errors with this apparatus. This note shows that a reduction in thickness of the air film does not produce the expected reduction in thermal resistance. E.H.Dock

536.212.2 : 538.66

2824. THERMAL MAGNETORESISTANCE OF ZINC AT LOW TEMPERATURES. P.B.Alers.
Phys. Rev., Vol. 101, No. 1, 41-8 (Jan. 1, 1956).

The variation of the low-temperature thermal resistance of single crystals of zinc in large magnetic fields has been investigated. The work was divided into two parts, one using very large fields ($H \leq 60$ kilogauss) and the other using fields ranging to 25 kilogauss. The high-field work was concerned mostly with the behaviour of the thermal magnetoresistance for various orientations of the crystalline axes relative to the magnetic field. It was found that the thermal magnetoresistance is a strong function of orientation in the field, and an attempt was made to extrapolate the data obtained to infinite fields. The low-field work was carried out primarily to investigate the de Haas—van Alphen effect, and electrical as well as thermal magnetoresistance data were taken. Oscillations of the de Haas—van Alphen type were found in both the thermal and the electrical magnetoresistance and an average value of $\beta^*/E_0 = 5.8 \times 10^{-5}$ gauss^{-1} was derived from the thermal data. Comparison with theory yielded a value of the order of 0.2 electron per atom for both the thermal and electrical cases. The variation of the Lorenz ratio with magnetic field was also derived. A.

536.23 : 536.44 : 533.15/.16 : 532.13

PROPERTIES OF GASES AND LIQUIDS WITHIN THE RANGE OF PRESSURES USED IN INDUSTRY. See Abstr. 1881

536.24

2825. THE EFFECT OF FLUID MOTION ON HEAT TRANSMISSION. III. SOLIDS OF DIFFERENT SHAPES AND SIZES. D.G.Kapadnis.
Indian J. Phys., Vol. 29, No. 6, 296-308 (June, 1955).

For Pt II, see Abstr. 5529 (1954). A detailed experimental study of the effect of a unidirectional stream of air on the rate of heat dissipation from solids of different shapes and sizes by forced convection has been made in a limited range of Reynolds numbers from 10^3 to 10^5. The experimentally derived values of the constants B and n in the Nusselts equation (employed for air), $[(1/A\Delta\theta)(dQ/dt)(D/K)] = B(VD/\xi)^n$, (the symbols have their usual meaning) are respectively 0.505 and 0.516 for horizontal cylinders with ellipsoidal nosepiece, 0.033 and 0.783 for the same with plane blunt nosepiece; 0.78 and 0.517 for spheres; 0.12 and 0.12 and 0.654 for rectangular parallelepipeds placed in face-on position; and 0.24 and 0.576 for the same placed in edge-on position. Finally the experimental data have been compared with those of other investigators. A.

536.25

2826. TURBULENT GRAVITATIONAL CONVECTION FROM MAINTAINED AND INSTANTANEOUS SOURCES. B.R.Morton, G.Taylor and J.S.Turner.
Proc. Roy. Soc. A, Vol. 234, 1-23 (Jan. 24, 1956).

Theories of convection from maintained and instantaneous sources of buoyancy are developed, using methods which are applicable to stratified body fluids with any variation of density with height; detailed solutions have been presented for the case of a stably stratified fluid with a linear density gradient. The three main assumptions involved are (i) that the profiles of vertical velocity and buoyancy are similar at all heights, (ii) that the rate of entrainment of fluid at any height is proportional to a characteristic velocity at that height, and (iii) that the fluids are incompressible and do not change volume on mixing, and that local variations in density throughout the motion are small compared to some reference density. The governing equations are derived in non-dimensional form from the conditions of conservation of volume, momentum and buoyancy, and a numerical solution is obtained for the case of the maintained source. This leads to a prediction of the final height to which a plume of light fluid will rise in a stably stratified fluid. Estimates of the constant governing the rate of entrainment

are made by comparing the theory with some previous results in uniform fluids, and with the results of new experiments carried out in a stratified salt solution. For the case of an instantaneous source of buoyancy there is an exact solution; the entrainment constant is again estimated from laboratory results for a stratified fluid. Finally, the analysis is applied to the (compressible) atmosphere, by making the customary substitution of potential temperature for temperature. Predictions are made of the height to which smoke plumes from typical sources of heat should rise in a still, stably stratified atmosphere under various conditions. A.

536.33.08

2827. A SIMPLE THEORY FOR SOLID-BACKED BOLOMETERS. L.M.Roberts and S.J.Fray.
J. sci. Instrum., Vol. 33, No. 3, 115-19 (March, 1956).

A simple theory is proposed to explain the frequency response of solid-backed bolometers. It assumes a one-dimensional flow of heat through the bolometer and takes into account the diffusivity of the adhesive used for sticking the bolometer element to its base. The theory has been applied to measurements on some niobium nitride superconducting bolometers and the results are in good agreement with the known properties of the materials used. A.

536.413

2828. THERMAL EXPANSION OF POTASSIUM IODIDE. R.Srinivasan.
Proc. Indian Acad. Sci. A, Vol. 42, No. 5, 255-60 (Nov., 1955).

The thermal expansion of two different specimens of potassium iodide was measured from liquid-air temperatures to 150°C. The expansion coefficient for the two specimens above room temperature are identical with one another. The high-temperature expansion was not influenced by heat or cold treatment of the specimens. Below 0°C the thermal expansion of potassium iodide exhibits an anomalous behaviour. Two maxima at −95° and −40°C and two minima at −60° and −25°C have been observed. As the length of the specimen varies continuously with the temperature, the transition in this crystal appears to be homomorphous. A.

536.423.1

2829. FILM BOILING OF WATER BY PULSE-HEATING SMALL WIRES. E.A.McLean, V.E.Scherrer and C.E.Faneuff.
J. appl. Phys., Vol. 27, No. 2, 193-4 (Feb., 1956).

Formation of vapour bubbles on a heated small diameter wire was examined by means of a high speed camera (5000 frames/sec). The wire (1-15 mils) was heated by square-wave repetitive power pulses so that boiling temperatures were attained without burning out the wire. Power input was up to 2 W-sec per pulse. Formation of the vapour film is illustrated by photographs of six typical frames. E.H.Dock

536.423.4

2830. MEASUREMENT OF CRITICAL SUPERSATURATION OF VAPOURS WITH THE DIFFUSION CLOUD CHAMBER. J.P.Franck and H.G.Hertz.
Z. Phys., Vol. 143, No. 5, 559-90 (1956). In German.

A specially constructed diffusion cloud chamber was used in condensation experiments with methyl and ethyl alcohol. Agreement was found with the theory of Becker and Döring. L.G.Carpenter

536.424.1 : 539.27

FIELD EMISSION MICROSCOPY OF AN ALLOTROPIC TRANSFORMATION: α—β TITANIUM. See Abstr. 2477

536.461 : 535.333

2831. THE HOMOGENEITY OF EXPLOSIONS INITIATED BY FLASH PHOTOLYSIS. B.A.Thrush.
Proc. Roy. Soc. A, Vol. 233, 147-51 (Dec. 6, 1955).

Photoelectric studies have been made of the light emitted from flash-initiated explosions of acetylene and oxygen photosensitized by nitrogen dioxide in a long quartz tube. These confirmed the presence of a very short-lived intense emission from the diatomic radicals which had previously been found by Norrish, Porter and Thrush (1953). It is shown that, whilst the main part of the explosion is homogeneous, two detonation waves travel a short distance to the ends of the reaction vessel. The sharp peak is caused by the impact of one of these detonation waves on the vessel window nearer the spectrograph. A.

536.48

2832. PROPERTIES OF INDIUM AND THALLIUM AT LOW TEMPERATURES. C.A.Swenson.
Phys. Rev., Vol. 100, No. 6, 1607-14 (Dec. 15, 1955).

The pressure-volume relationships for superconductors near absolute zero are of potential interest for comparison with theories which attempt to explain the variation of the superconducting transition temperature with pressure. Such data for thallium are of special interest since the variation of transition temperature with pressure is different for thallium than for any other known pure metal. In these experiments, measurements on indium of the total compression to 10 000 atm for various temperatures down to 4.2°K served as a check of similar measurements on thallium. No unusual behaviour was found for either metal. These results were combined with the measurement of the total thermal expansions for both metals to give isobars at both zero pressure and at 10 000 atm pressure over the range from 4.2° to 300°K. The results of some low-temperature compressive testing experiments on both metals are also given, together with some indirect evidence as to the vanishing of work hardening effects at low temperature and moderate hydrostatic pressures. Finally, measurements on the electrical resistance of indium show an unexplained kink in the R v. T curve at about 210°K. The effect on the electrical resistance of indium due to tensile (plastic) deformation at 4.2°K was also measured. A.

536.48

2833. ON THE SPECTRUM OF ELEMENTARY EXCITATIONS IN SUPERFLUID HELIUM. C.G.Kuper.
Proc. Roy. Soc. A, Vol. 233, 223-32 (Dec. 20, 1955).

Feynman (Abstr. 6569/1954) has advanced physical arguments to deduce an approximate form for the wave-function of an elementary excitation in helium. Qualitatively, his theory leads to an excitation spectrum similar to that postulated by Landau; however, serious quantitative descrepancies remain in the "roton" region of the spectrum. It is shown here that improved wave-functions may be constructed by using combinations of wave-functions for single and double Feynman excitations — this amounts to a self-energy correction to the roton spectrum, arising mainly from roton-phonon interactions. The numerical value of the roton energy agrees remarkably well with Landau's value. The treatment depends, however, on the use of perturbation theory, where the perturbation is not small. Little confidence should therefore be placed in the actual value found. A.

536.48 : 530.162

NONEQUILIBRIUM NATURE OF THE SUPERFLUID STATE AND CONNECTION WITH SUPERCONDUCTIVITY. See Abstr. 1869

536.48 : 537.312.62 : 530.162

CONNECTION BETWEEN SUPERFLUIDITY AND SUPERCONDUCTIVITY. See Abstr. 1870

536.52. : 535.343

2834. SPECTRAL ABSORPTION METHOD FOR DETERMINING POPULATION "TEMPERATURES" IN HOT GASES. H.J.Kostowski and H.P.Broida.
J. Opt. Soc. Amer., Vol. 46, No. 4, 246-54 (April, 1956).

A spectroscopic method, useful for strongly absorbed

lines, has been investigated for measuring temperatures of hot gases. The minimum transmission of discrete spectral lines in gases at equilibrium has a simple dependence upon the absolute temperature and this relation is used to measure temperature from a straight line plot. An experimental study has been made of the absorption due to the rotational lines of OH ($^2\Sigma \leftarrow {}^2\Pi$) between 3067 and 3090 A in an oxygen-acetylene flame. It is shown that temperatures measured by this method are less affected than the conventional one by lack of sufficient resolving power, flame thickness, and various light sources (either continuous or line). A.

536.531

2835. RESISTANCE THERMOMETER FOR TRANSIENT HIGH-TEMPERATURE STUDIES. J.Rabinowicz, M.E.Jessey and C.A.Bartsch.
J. appl. Phys., Vol. 27, No. 1, 97-8 (Jan., 1956).

Temperatures in shock tube research are measured by using thin Pt films as resistance thermometers. The films are produced by sputtering the metal on to Pyrex glass and the thickness is varied by altering the sputtering time from 15 min to 1½ hr. Response times of better than 1 microsec have been obtained in the measurement of heat transfer rates.

E.H.Dock

536.531 : 621.316.89

2836. THE STABILITY OF THERMISTORS. A.Beck.
J. sci. Instrum., Vol. 33, No. 1, 16-18 (Jan., 1956).

Although thermistors may reach a state where their constants remain stable, they may later undergo a change which takes place in an arbitrary manner. It is shown to be still possible, within certain limits, to obtain relative temperatures accurate to within 0.02 deg C. A.

536.532

2837. THE LIMITATIONS OF METHODS FOR MEASURING SMALL TEMPERATURE DIFFERENCES AND QUANTITIES OF HEAT, AND A DESCRIPTION OF A THEORY OF THE "THERMONEEDLE". R.Dahlberg.
Z. Naturforsch., Vol. 10a, No. 12, 953-70 (1955); Erratum, Vol. 11a, No. 1, 100 (1956). In German.

The need for thermocouple units of small heat capacity and conductivity exists in a number of sciences and examples are outlined. Literature on such thermo-elements is discussed and the construction of the thermoneedle is then described. It is made of glass and has appropriate metallic deposits on two opposite sides, the so-called valve metals being used. Several pairs of metals have been used and tested and the properties of the needles are given. The theory is developed on the basis of the thermo-element as a heat engine, and then as a measuring unit. Properties of twenty-four pairs of metals are tabulated. Finally some special uses of the thermoneedle are indicated.

E.H.Dock

536.532

2838. EXPERIMENTS ON THERMOCOUPLES MADE FROM THE IRIDIUM/RHENIUM SYSTEM. G.Haase and G.Schneider.
Z. Phys., Vol. 144, No. 1-3, 256-62 (1956). In German.

The thermoelectric powers of Ir, Re and of various alloys were measured against W up to 2450° C, 50° higher than previous measurements on metals. It was found that a couple consisting of Ir and an alloy Ir 30%, Re 70% was of practical use in the measurement of temperatures even in a slightly oxidizing atmosphere, a little above 2000° C. C.A.Hogarth

536.631

2839. RESULTS OF INVESTIGATIONS AT LOW TEMPERATURES. XV. DETECTION OF ELECTRONIC HEAT IN METALS. K.Clusius and H.H.Bühler.
Z. Naturforsch., Vol. 10a, No. 12, 930-8 (1955). In German.

For Pt XIV, see Abstr. 9617 (1955). It is shown that the γ values of equation $c_v = c_g + c_e = 464.5(T/\theta\,{}^*g)^3 + \gamma T$, where c_g and c_e are the lattice and electronic heat, respectively, and $\theta\,{}^*g$ is the Debye characteristic temperature, can be also applied to "medium" temperatures (above 20° K). The range involved, in which the lattice heat approaches (but is always less than) the equipartition value of 3R cal/°g-atom, is called the equipartition range. It was found that all metals show in this range a decrease of θ when T increases; this points to the existence of a heat capacity which seems to be identical with c_e. The pure lattice heat ($c_v - c_e$) gives θ values converging towards a constant when T increases. The Debye function is very sensitive to increase in c_e, both below and above 20° K. The existence of c_e in the equipartition range has been proved for Ag, Cu, Al, Mg, Tl, Zr, V and U.

F.Lachman

536.631

2840. RESULTS OF INVESTIGATIONS AT LOW TEMPERATURES. XVI. ATOMIC AND ELECTRONIC HEAT OF TANTALUM BETWEEN 10° AND 273° K. K.Clusius and C.G.Losa.
Z. Naturforsch., Vol. 10a, No. 12, 939-43 (1955). In German.

The standard entropy of Ta at 25° C was found to be 9.90 eu. Below 19° K the atomic heat $c_p = c_v = c_g + c_e = 464.5(T/228)^3 + 8.1 \times 10^{-4}T$. Above 20° K the electronic heat causes an abrupt fall of the Debye values θ, which finally disappear at 270° K ($=T_0$). This temperature yields a value for γ which, in turn, results in a nearly constant (between 230 and 240° K) characteristic Debye temperature θ_g for the lattice heat.

F.Lachman

536.631

2841. THE SPECIFIC HEATS OF POTASSIUM, RUBIDIUM AND CAESIUM AT TEMPERATURES BELOW 330° K.
T.M.Dauphinee, D.L.Martin and H.Preston-Thomas.
Proc. Roy. Soc. A, Vol. 233, 214-22 (Dec. 20, 1955).

The specific heats were measured within the temperature range ~ 20 to 330° K. As in the case of sodium (Abstr.3395/1954), anomalies were found in the specific heats of all these metals. The anomaly in rubidium is found to be affected by heat treatment of the sample. The caesium measurements give direct calorimetric information relating to the caesium-oxygen binary system. A.

536.655 : 532.612.4

VARIATION OF SURFACE TENSION AND HEAT OF VAPORIZATION WITH TEMPERATURE. See Abstr. 1887

THERMODYNAMICS 536.7/.8

536.7 : 539.133

2842. STATISTICAL THERMODYNAMICS OF SEMI-FLEXIBLE CHAIN MOLECULES. P.J.Flory.
Proc. Roy. Soc. A, Vol. 234, 60-73 (Jan. 24, 1956).

Long-chain polymer molecules are approximated by a model consisting of isodimensional segments which tend to arrange themselves in co-linear succession. A fraction f of the bonds is assumed to be "bent" out of the co-linear direction of preceding segments. The fact that the free energy of solution derived using the lattice model separates into (a) a mixing term dependent only on the concentration, and (b) a disorientation term depending on f but not on the concentration, leads to the concept of an equilibrium "flexibility" f which is characteristic of the polymer chain at a given temperature. This f must exceed a specified critical value, which decreases with dilution if the disordered phase usually considered to occur is to be more stable than an ordered one in which the chains assume their preferred rod-like form and lie parallel to one another. Transition between the two states should be co-operative, and should involve a latent heat (owing to the change in intramolecular configurational energy) even in the absence of a change in the intermolecular energy. The concept of a phase transition

due solely to intramolecular forces thus arises. Configurational dimensions of various polymers are such as to suggest that inflexibility may be a dominant factor in causing them to crystallize. This is certainly true for cellulose derivatives, probably also for polytetrafluoroethylene, and possible for polymethylene as well. Intramolecular forces favouring the rod-like form are, doubtless of major importance also in bringing about crystallization of proteins in the α-form. A.

536.7 : 541.122

2843. THERMODYNAMIC FUNCTIONS OF CYANOGEN AND THE EQUILIBRIUM CONSTANTS FOR THE REACTION $\frac{1}{2}C_2N_2 \rightleftharpoons CN$ BETWEEN 1000° AND 4500° K. E.Rutner, W.H.McLain, Jr and K.Scheller.
J. chem. Phys., Vol. 24, No. 1, 173 (Jan., 1956).

A table gives heat capacity, enthalpy, free energy and equilibrium constants calculated from assumed vibration frequencies and moment of inertia. G.F.Lothian

536.73

2844. SECOND LAW OF THERMODYNAMICS APPARATUS. M.B.Cole and L.R.Ingersoll.
Amer. J. Phys., Vol. 24, No. 3, 172-3 (March, 1956)

Satisfactory laboratory apparatus — based on the electric refrigerator — for demonstration and quantitative work with the second law of thermodynamics has been devised and is now in use at the University of Wisconsin and the Missouri School of Mines and Metallurgy. The design and operation of the Wisconsin apparatus is described and the possible calculations discussed. A.

ELECTRICITY 537

ELECTROSTATICS. DIELECTRICS 537.2

537.211 : 621.315.59 : 621.838.3

2845. SOME THEORETICAL AND PRACTICAL CONSIDERATIONS OF THE JOHNSEN–RAHBEK EFFECT. A.D.Stuckes.
Proc. Instn Elect. Engrs, Paper No.2007 M, publ. March, 1956 (Vol. 103 B, 125-31).

A theory of electrostatic attraction, influenced by field emission, is proposed to explain the Johnsen–Rahbek effect between the flat and polished surfaces of a metal and a semiconductor in contact. The application and advantages of the effect as a clutch are described, and the results of a large number of life tests are summarized. It is concluded that the unreliability of such a clutch, due mainly to different amounts of wear, is caused by relatively small differences in the polished surfaces. Consequently it is suggested that the electrostatic clutch is not, in general, a practical proposition, but more likely applications of the effect lie in relay devices and valves for controlling gas flow. A.

537.212 : 537.224 : 621.3.011.4 : 621.319.4

2846. THE CAPACITY AND FIELD OF A CYLINDRICAL TROUGH WITH A PLANE CONDUCTOR IN THE AXIAL PLANE OF SYMMETRY. H.J.Peake and N.Davy.
Brit. J. appl. Phys., Vol. 6, No. 11, 404-8 (Nov., 1955).

The transformation $z = b\,cn(Kw/U)$ is taken as basic, and from this the complex potential, field and capacitance of a condenser, consisting of an infinite cylindrical trough and an infinite plane conductor of finite width situated in the axial plane of symmetry, are obtained by the method of inversion. In two special cases, tables are provided giving the values of the electrical intensity at points on the axes of symmetry and the surface density of charge at points on the conductors. Tables and graphs are given which enable the capacitance to be readily calculated. A.

537.222.1

2847. THE ELECTROSTATIC CENTRE OF A CONDUCTOR. R.Cade and D.O.Vickers.
Proc. Phys. Soc. B, Vol. 69, Pt 2, 175-9 (Feb., 1956).

It is shown that relative to a conductor influenced by a uniform electric field, there exists a fixed point with special properties. If the conductor has no total charge, its potential is always the same as that of the uniform field alone at this point. When the moment of the electrostatic forces on the conductor is taken about the point, the value is the same whether or not the total charge is zero. The general principles are illustrated by results on a special problem. A.

537.226 : 535.376 : 621.3.011.5

2848. DIELECTRIC BEHAVIOR OF ELECTROLUMINESCENT ZINC SULFIDES. W.Lehmann.
J. Electrochem. Soc., Vol. 103, No. 1, 24-9 (Jan., 1956).

The complex dielectric factor of electroluminescent zinc sulphides was measured as a function of the voltage and frequency applied to the electroluminescent cell. Both the real and the imaginary part of the dielectric factor obey the law: $k = k_0 +$ function of (L/f), where L is the time average of the electroluminescent emission and f is the frequency. For low and moderate voltages, this expression becomes $k = k_0 + c(L/f)^{1/2}$, where k_0 may depend on frequency f, but c is a constant independent of voltage and frequency. A.

537.226 : 621.319.1

2849. SOME ASPECTS OF FERROELECTRICITY. G.Shirane, F.Jona and R.Pepinsky.
Proc. Inst. Radio Engrs, Vol. 43, No. 12, 1738-93 (Dec., 1955).

Some recent developments in the study of ferroelectricity are described. Special consideration is given to crystal and domain structures and their contributions to the dielectric behaviour of ferroelectrics and antiferroelectrics. 166 refs. A.

537.226.1.08

2850. THREE-TERMINAL DIELECTRIC CELL WITH A FLOATING MICROMETER ELECTRODE. R.N.Work.
Rev. sci. Instrum., Vol. 26, No. 12, 1171-5 (Dec., 1955).

A description is given of a three-terminal cell for dielectric measurements on polymeric materials over a wide temperature range. Use is made of a lightly spring-loaded, floating electrode to maintain good electrical contact with the specimen when it expands or contracts thermally. A differential capacitor, built into the movable electrode, is used with a simple detector circuit to indicate the position of the electrode with respect to its micrometer-driven carriage. Simultaneous measurements can be made of cell capacitance and electrode separation. The latter can be determined with a precision of better than 10^{-4} in. Provision is made to confine the specimen when it softens at temperatures above its glass-transition temperature. The cell has been operated successfully at frequencies between 20 c/s and 1 Mc/s and at temperatures between 20 and 200° C. A.

537.226.1.08

2851. CELL WITH FIXED ELECTRODES FOR THE MEASUREMENT OF THE DIELECTRIC CONSTANT OF A LIQUID. C.Abgrall.
C.R. Acad. Sci. (Paris), Vol. 242, No. 1, 76-8 (Jan. 4, 1956). In French.

Describes, with a cross-sectional diagram, a simple cylindrical cell: the demountable inner electrode system employs Teflon insulation and includes a built-in disconnection arrangement. An alternative cell with adjustable inner electrode is briefly outlined. F.F.Roberts

537.226.2

2852. ON THE DIELECTRIC DISPERSION OF POLAR LIQUIDS. E.Schulz-Du Bois.
Z. Phys., Vol. 144, No. 1-3, 76-9 (1956). In German.

The experimental data of Meckbach (Abstr. 5763/1952) for α-brom-naphthalene are shown to be expressible, within the experimental accuracy, in terms of the superposition of two relaxation components centred on wavelengths of 16 cm and 2.1 cm respectively. It is suggested that the 2.1 cm component could be a (heavily-damped) resonance. Data for water, methyl and ethyl alcohol are compared. F.F.Roberts

537.226.2

2853. ABSORPTION AND DISPERSION OF MICROWAVES IN METHYL BROMIDE. P.Swarup.
Z. Phys., Vol. 144, No. 5, 632-6 (1956). In German.

The absorption and dispersion in case of CH_3Br at moderate pressures in the microwave region due to the pressure-broadened inversion spectrum ($\bar{\nu}_{JK} = 0$) is analysed on the basis of the quantum-mechanical expressions of Van Vleck—Weisskopf for absorption and dispersion. Theoretical and experimental data are compared. A.

537.226.2

2854. MICROWAVE DIELECTRIC CONSTANT MEASUREMENTS. D.W.Magnuson.
J. chem. Phys., Vol. 24, No. 2, 344-7 (Feb., 1956).

An improved microwave cavity technique for measuring dielectric constants was used to determine the molar polarization, dipole moment, and nonideality of UF_6, Freon-114, $C_4Cl_3F_7$, and C_6H_6. Nonideality parameters were calculated for ClF_3 from previous data. A.

537.228.2

2855. ON THE MOLECULAR THEORY OF ELECTROSTRICTION. B.K.P.Scaife.
Proc. Phys. Soc. B, Vol. 69, Pt 2, 153-60 (Feb., 1956).

In order to obtain a better understanding of the phenomenon of electrostriction, the particular case of a sphere of fluid dielectric, subjected to a uniform external field, is considered. The problem is discussed from both macroscopic and microscopic points of view. That part of the spur of the stress tensor $3\Delta P$ which depends quadratically on the applied field is calculated for both non-polar and dipolar dielectrics. It is found that the Lorenz-Lorentz and Debye theories of dielectrics lead to the singular result that ΔP is zero. The reason for this is discussed, and it is shown that the more modern theories of Yvon and Kirkwood and of Onsager do not lead to such a result. A.

ELECTRIC CONDUCTION. CURRENTS 537.3

537.311.1

2856. STUDY OF THE RESISTIVITY AND THERMOELECTRIC POWER OF DISSOLVED IMPURITIES IN THE NOBLE METALS. P. de Faget de Casteljau and J.Friedel.
J. Phys. Radium, Vol. 17, No. 1, 27-32 (Jan., 1956). In French.

The diffusion of a free electron gas by a spherical potential well of fixed radius and variable depth is investigated theoretically. For weak potentials the model developed accounts very satisfactorily for polyvalent impurities dissolved in the noble metals. Resonance effects associated with bound levels such as 2p, 3d, and so on produce larger potentials and enable the effects of transition metals in the noble metals to be investigated. C.A.Hogarth

537.311.3 : 536.21

THE CONDUCTIVITY OF DEPOSITED CARBON. See Abstr. 2028

537.311.31 : 536.48

2857. THE CONDUCTIVITY OF SODIUM AT LOW TEMPERATURES. S.B.Woods.
Canad. J. Phys., Vol. 34, No. 2, 223-6 (Feb., 1956).

Reports results of measurements between 4° and 15° K. The resistivity was found to obey Matthiessen's rule, with $\rho_0 = 1.38 \times 10^{-9}$; $\rho_i = 8.6 \times 10^{-16} T^6$ ($4^\circ < T < 9^\circ$), $8.4 \times 10^{-18} T^8$ ($8^\circ < T < 15^\circ$ K) (in units ohm cm). E.P.Wohlfarth

537.311.31 : 539.32

2858. ON THE MEASUREMENT OF ELECTRIC CONSTANTS OF THIN METALLIC FILMS. G.Bonfiglioli, E.Coen and R.Malvano.
J. appl. Phys., Vol. 27, No. 3, 201-3 (March, 1956).

Deals with Hall effect and specific conductivity measurements in the case of a nonuniform current density field (that is, when the specimen is not a parallelepiped but has irregularly waved surfaces). It is then impossible to measure separately R_H (Hall coefficient) and σ (conductivity); it is possible, however, to get their product, the Hall mobility of the carriers. These conclusions are important when dealing with thin films, where the actual geometry of the surface is completely unknown. These remarks are used to interpret the results of some experiments on Au films evaporated on mica. An almost constant mobility is found v. mean thickness, but its magnitude is about $\frac{1}{4}$ the bulk mobility. This behaviour raises some question about the structure of thin films, and some connection seems to hold between the experiments here described and the results of the measurements of the optical constants of metals. A.

537.311.32 : 548.7

2859. CONDUCTANCE MECHANISMS AND THE THERMAL TRANSITION IN CAESIUM CHLORIDE. W.W.Harpur and A.R.Ubbelohde.
Proc. Roy. Soc. A, Vol. 232, 310-19 (Nov. 8, 1955).

Experiments on the abnormal conductance of caesium chloride (Abstr. 9647/1955) show that this can be altered in various ways. Methods described include heating the salt at 400° C in atmospheres with controlled partial pressures of oxygen, or in nitrogen containing gaseous hydrogen chloride. The conductance of samples of caesium chloride treated with hydrogen chloride show a pre-transition increase of lattice defects on approaching the transition bcc → fcc at 469° C. Micro-analyses show a ratio $([Cs^+] - [Cl^-])/[CsCl]$ in the salt as ordinarily obtained, ranging from about 0.000 018 to 0.000 13. After heating in oxygen this can rise to as much as 0.000 66. It is suggested that some of the vacant chloride-ion sites are occupied by the O^{2-} ion. After prolonged heating in oxygen caesium chloride exhibits oxidizing properties which are tentatively attributed to a proportion of divalent caesium ions of the order of magnitude $[Cs^{2+}]/[Cs^+] = 0.0007$. After treatment with a mixture of hydrogen chloride and nitrogen, this oxidizing power and the excess caesium ratio fall below the limit of detection. Possible conductance mechanisms are discussed in the light of these experiments. The results also give additional information about the nature of the thermal transition. This shows marked hysteresis, suggesting some smearing of the free-energy curves of the two phases due to co-existence, within one crystal, of subcrystalline regions of the two crystal phases over a narrow range of temperatures, with contributions to the free energy from strain and internal surface energy. A.

537.311.33 : 621.315.59

2860. HISTORY OF SEMICONDUCTOR RESEARCH. G.L.Pearson and W.H.Brattain.
Proc. Inst. Radio Engrs, Vol. 43, No. 12, 1794-806 (Dec., 1955).

Surveys semiconductor research from its earliest beginnings up to the present day, with special emphasis on the inception of new ideas and the resolution of older discrepancies. 118 references are given. A

537.311.33

2861. AMBIPOLAR THERMODIFFUSION OF ELECTRONS

AND HOLES IN SEMICONDUCTORS. P.J.Price.
Phil. Mag., Vol. 46, 1252-60 (Nov., 1955).

A formula for the magnitude of the ambipolar flux is derived, and is applied to the electronic contribution to the thermal conductivity and to the Nernst effect. The anomalous thermal conductivity of indium antimonide, reported by Busch and Schneider, cannot be accounted for in terms of the energy transported by this ambipolar flow. A.

537.311.33

2862. NEW SEMICONDUCTING COMPOUNDS. E.Mooser and W.B.Pearson.
Phys. Rev., Vol. 101, No. 1, 492-3 (Jan. 1, 1956).

From measurements of resistivity and Hall coefficient between 80°K and the melting point, the following were found to show typical semiconducting properties: Ag_2Se, Li_3Bi, TlSe, "Tl_2Se_3", SnSe, $SnSe_2$, In_2Tl_3, $InTe_3$, $AgInTe_2$. Metallic behaviour was found in Tl_2Se, BiSe, Bi_2Se_3, In_2Te, InTe, TlTe. Microscopic examination showed that "Tl_2Se_3" was not a true single phase; its behaviour was probably due to the presence of TlSe. R.G.Chambers

537.311.33

2863. EFFECTS OF PRESSURE ON THE ELECTRICAL PROPERTIES OF SEMICONDUCTORS. D.Long.
Phys. Rev., Vol. 101, No. 4, 1256-63 (Feb. 15, 1956).

Measurements have been made of the effects of hydrostatic pressures between one and 2000 atm on the electrical properties of several different semiconductors. The materials studied are germanium, indium antimonide, indium arsenide, gallium antimonide, tellurium and magnesium stannide. It has been found that the temperature at which the Hall coefficient of p-type Ge reverses sign shifts to a higher value under the application of a pressure of 2000 atm, and that the magnitude of the shift is in good agreement with the shift predicted by the known increase of the energy gap from one to 2000 atm. The transverse magnetoresistance of InSb is found to decrease slightly with increasing pressure in accordance with the known decrease of electron mobility. Conductivity and Hall coefficient v. pressure measurements on extrinsic n-type samples of InAs and GaSb show that the electron mobility in InAs decreases by about 7% from one to 2000 atm and that there is no such mobility change in GaSb. Conductivity and Hall coefficient v. pressure measurements on Te indicate that the energy gap is smaller by 0.032 eV at 2000 atm than its value of about 0.336 eV at atmospheric pressure, and that the hole and electron mobilities increase with increasing pressure. A consistent scheme of interpretation of the results of the various pressure experiments on tellurium is proposed. Conductivity v. pressure measurements on Mg_2Sn show that the energy gap widens with increasing pressure by roughly 0.01 eV between one and 2000 atm. A.

537.311.33 : 548.7

2864. EFFECT OF DISLOCATIONS ON THE MINORITY CARRIER LIFETIME IN SEMICONDUCTORS. A.D.Kurtz, S.A.Kulin and B.L.Averbach.
Phys. Rev., Vol. 101, No. 4, 1285-91 (Feb. 15, 1956).

The density of random dislocations in germanium and silicon crystals has been measured by means of X-ray rocking curves and by etch pit counting. Data obtained by the two methods are in good agreement, and dislocation densities in the range 10^4-10^7/cm^2 were found. The minority carrier lifetime was shown to vary with the dislocation density, and the results could be expressed in terms of a recombination efficiency per unit length of dislocation line, $\sigma_R = 1/N_D\tau$ (where N_D = dislocation density, τ = lifetime). σ_R was found to decrease with increasing resistivity of germanium and was higher for silicon than for germanium of comparable purity. A.

537.311.33

2865. SIMULTANEOUS TRANSPORT OF HEAVY AND LIGHT HOLES IN SEMICONDUCTORS WITH A DEGENERATE VALENCE BAND. E.S.Rittner.
Phys. Rev., Vol. 101, No. 4, 1291-4 (Feb. 15, 1956).

A theoretical study is presented of the motion in an n-type semiconducting filament of an injected narrow pulse of slow and fast holes subject to drift, diffusion, recombination, and reversible interband transitions. For low injection level and for interband transition times which are small compared to the recombination lifetime and to the observation time but large compared to the time between collisions, it is shown that both sets of holes propagate and broaden as a single pulse with a group mobility and diffusivity heavily weighted by that of the slower holes. This explains why only a single pulse is observed at the collector in drift mobility experiments. A.

537.311.33

2866. THE TRANSPORT OF INJECTED ELECTRONS AND HOLES IN A SEMICONDUCTOR. R.Gevers.
Physica, Vol. 21, No. 11, 888-96 (Nov., 1955).

By using Laplace transformation, the solution of the system of differential equations, describing the transport of added current carriers in a homogeneous semiconductor, can be found to a high degree of approximation for the small signal case and for sufficient small concentrations of added carriers. For times, much larger than the relaxation time, the result obtained agrees with the one derived by Keilson in another way (Abstr. 446/1954). During relaxation the part of the flow which eventually provides the establishment of a strict overall and an approximate local charge neutrality can be given in function of a diffusion coefficient and a mobility which differ from those needed for the description of the other part. This last part is the only one which is not negligible after relaxation. By using the same method, an approximate value can be calculated for the small local space charge occurring during the transport of the added current carriers and the physical interpretation of the result is straightforward. It can be shown that the polarizability of each injected pair "electron-hole" calculated by Keilson for a static field, becomes complex for an alternating field and this corresponds to the relaxation in the reorientation of the local space charge. A.

537.311.33

2867. ON THE TRANSPORT PROPERTIES OF METALS AND SEMI-CONDUCTORS. D.ter Haar.
Physica, Vol. 22, No. 1, 61-8 (Jan., 1956).

It is shown how simple kinetic arguments can be used to derive approximate expressions for the thermal conductivity, electrical conductivity, thermoelectric power, Hall constant, and magnetoresistance of metals and semiconductors, including in some cases the contribution from lattice currents. A.

537.311.33

2868. OPTICAL DETERMINATION OF TEMPERATURE-DEPENDENCE OF ENERGY GAP IN SEMICONDUCTORS OF TYPE $A^{III}B^{V}$. F.Oswald.
Z. Naturforsch., Vol. 10a, No. 12, 927-30 (1955). In German.

Reports measurements on the absorption edges of InAs, InP, GaAs, GaP, InSb, from 100°K to 500°K. R.G.Chambers

537.311.33

2869. ON THE VARIATION OF CONTACT POTENTIAL WITH TEMPERATURE. G.C.Mönch.
Z. Phys., Vol. 144, No. 1-3, 263-8 (1956). In German.

Measurements of the contact potential against a metal electrode were made as a function of temperature for the following materials: Ag_2S, 130 to 220°C; AgI, 80 to 210°C; Cu_2O, 30 to 400°C. The variations are dependent on the nature of the contact electrode, and the results are briefly discussed in terms of free carrier concentrations in the contact region and changes in the lattice constant. C.A.Hogarth

537.311.33 : 548.55

PROPERTIES OF A LARGE SINGLE CRYSTAL OF CADMIUM SELENIDE. See Abstr. 2536

537.311.33

2870. INVESTIGATIONS OF SURFACE RECOMBINATION VELOCITIES ON GERMANIUM BY THE PHOTOELECTROMAGNETIC METHOD. T.M.Buck and W.H.Brattain.
J. Electrochem. Soc., Vol. 102, No. 11, 636-40 (Nov., 1955).

The photoelectromagnetic, or "deathnium meter", method has been used to detect changes in surface recombination velocity on germanium produced by various chemical surface treatments and by heating to temperatures of 65°-100° C. The method consists of measuring the open-circuit voltage due to the P.E.M. effect. Measurements may be made rapidly; small changes in specimen thickness caused by a surface treatment may be ignored; the method can be used to investigate surfaces covered by opaque protective coatings. While it was found that the open-circuit voltage depended on surface recombination in a manner which agreed qualitatively with theory, the agreement was not good enough to permit calculation of quantitative values of recombination velocity. A.

537.311.33 : 535.39

2871. USE OF INFRARED ABSORPTION TO DETERMINE CARRIER DISTRIBUTION IN GERMANIUM AND SURFACE RECOMBINATION VELOCITY. N.J.Harrick.
Phys. Rev., Vol. 101, No. 1, 491-2 (Jan. 1, 1956).

Holes were injected or extracted at one end of a p-type Ge bar of high bulk carrier lifetime, and measurements were made of the resulting change of infrared absorption at various points across the width of the bar. The change was greatest at the centre and least at the sides, and agreed closely with theory. It is deduced that for etched surfaces, the surface recombination velocity was 250 cm/sec, and for ground surfaces 1900 cm/sec, to within 25%. R.G.Chambers

537.311.33

2872. THERMALLY INDUCED ACCEPTORS IN GERMANIUM. R.A.Logan.
Phys. Rev., Vol. 101, No. 5, 1455-9 (March. 1, 1956).

When germanium is rapidly quenched from high temperature, acceptor centres are formed uniformly throughout the crystal. These centres have an energy of formation of about 2 eV. Each centre is thought to contribute two acceptors, one near the valence band and one near the centre of the gap. Experiments are described which indicate that these centres are either vacant lattice sites or a heretofore unidentified chemical impurity with radius smaller than that of germanium. Annealing has been studied in the temperature range 250° C - 450° C. The annealing process is shown to depend markedly on both the density of dislocations and the concentration of copper. It has not been possible to ascribe a consistent physical model to conform with the observed characteristics of the annealing process. A.

537.311.33

2873. SOME MEASUREMENTS CONNECTED WITH CARRIER DEFICIT PHENOMENA IN GERMANIUM. A.Many, D.Gerlich and E.Harnik.
Proc. Phys. Soc. B, Vol. 68, Pt 11, 970-2 (Nov., 1955).

Measurements of the exclusion ratio γ_{ex} analogous to the injection ratio are described for Ge filaments and the value of γ_{ex} is found to be independent of current. The temperature variation of γ_{ex} enables the values of energy gap E and the constant A in the usual carrier concentration equation $np = AT^3\exp(-E/kT)$ to be determined. The recovery process following exclusion is not always truly exponential. C.A.Hogarth

537.311.33

2874. SURFACE STATES ON SILICON AND GERMANIUM SURFACES. H.Statz, G.A.deMars, L.Davis, Jr and A.Adams, Jr.
Phys. Rev., Vol. 101, No. 4, 1272-81 (Feb. 15, 1956).

On silicon and germanium, steady-state and nonsteady-state p-type inversion layer conductance measurements can be understood in terms of two sets of surface states: one with a great density outside the oxide and the other with a smaller density at the semiconductor-semiconductor oxide interface. The interface states in silicon and germanium lie 0.455 and 0.138 eV, respectively, below the middle of the gap. There may also be interface states in the upper half of the gap; however, for their determination, measurement on n-type inversion layers would have to be made. The density of the interface states in silicon is about 1.4×10^{12} states/cm^2; the density in germanium is one-tenth this value. Various mechanisms of charge transfer through the oxide film are considered and compared with experimental data. A.

537.311.33

2875. THE ELECTRONIC ENERGY BAND STRUCTURE OF SILICON AND GERMANIUM. F.Herman.
Proc. Inst. Radio Engrs, Vol. 43, No. 12, 1703-32 (Dec., 1955).

Essentially an introduction to the quantum theory of crystals, with silicon and germanium serving as illustrative examples. The following topics are treated: crystal symmetry and crystal geometry; electronic quantum states in a perfect crystal; the energy band scheme; occupancy of the electronic quantum states; the hole concept; the effective mass tensor; velocity and acceleration of electrons and holes; the spin-orbit interaction and its consequences; the energy band structures of silicon and germanium; the band structure of germanium-silicon alloys; theory of lattice vibrations; the phonon concept; collisions between electrons or holes and phonons; the electrical conductivity; optical absorption and emission processes. 71 references. A.

537.311.33

2876. THE EFFECT OF ILLUMINATION ON THE EXCESS NOISE OF SILICON FILAMENTS. C.A.Hogarth and W.Bardsley.
Proc. Phys. Soc. B, Vol. 68, Pt 11, 968-70 (Nov., 1955).

Following similar studies on germanium (Abstr. 4539/1954) reduction of noise in silicon filaments was found to occur on illumination. It is assumed that light liberated minority carriers fill the traps and reduce their effect on current gain. The reduction was larger for small sweeping currents and larger for p-type material than n-type of equivalent purity. G.F.J.Garlick

537.311.33

2877. ON CERTAIN ELECTRICAL PROPERTIES OF TITANIUM NITRIDE AND TITANIUM CARBIDE. A.Münster and K.Sagel.
Z. Phys., Vol. 144, No. 1-3, 139-51 (1956). In German.

Measurements of the temperature variation of conductivity, of the Hall effect, and of the susceptibility, on crystals of TiC and TiN prepared from the vapour phase are reported. When deposited on metallic or Al_2O_3 substrates they show metallic conduction. If deposited on silica they show a negative temperature coefficient of resistance. No superconductivity is observed down to 1.6° K. The metallic forms and the semiconducting TiN show a weak paramagnetism; the semiconducting TiC is diamagnetic. The possibility of the uptake of oxygen from SiO_2 at the high temperature of reaction causing the semiconducting properties is discussed. C.A.Hogarth

537.311.33

2878. MOBILITY IN ZINC BLENDE AND INDIUM ANTIMONIDE. W.A.Harrison.
Phys. Rev., Vol. 101, No. 2, 903 (Jan. 15, 1956).

Crystals of the sphalerite structure are piezoelectric and the acoustic modes of thermal vibration in zinc blende and InSb will therefore entail electric polarization. Expressions are given for the relaxation time for electron scattering due to the associated periodic electric potential, and for the related drift mobility at temperatures low enough to avoid degeneracy of the conduction electrons. Some of the limited relevant experimental data are briefly noted. F.F.Roberts

537.311.33

2879. SPECTRAL ANALYSIS OF THE INTENSITY OF FLUCTUATIONS IN GERMANIUM DIODES AT LOW FREQUENCIES. J.P.Borel, C.Manus and R.Mercier.
Helv. phys. Acta., Vol. 28, No. 5-6, 454-8 (1955). In French.

Deviations from the noise fluctuations vs. frequency relations at low frequencies are examined (range 10-104 c/s). There is evidence of a saturation of mean noise as the frequency approaches 10 c/s. G.F.J.Garlick

537.311.33

2880. ON A SPECIAL FORM OF THE EQUATIONS WHICH GOVERN THE PROPAGATION OF FREE CARRIERS IN A ONE-DIMENSIONAL JUNCTION STRUCTURE IN A HOMOGENEOUS CRYSTAL. A.Leblond.
C.R. Acad. Sci. (Paris), Vol. 242, No. 1, 85-7 (Jan. 4, 1956). In French.

The transport equations are put into a form suitable for numerical integration. C.A.Hogarth

537.311.6

2881. INDUCTIVE AND CAPACITIVE REACTANCE. E.G.Albert.
Amer. J. Phys., Vol. 24, No. 3, 170-1 (March, 1956).

A method of determining from a vector diagram the inductive reactance of an inductor in terms of the circuit constants and for determining the capacitive reactance of a capacitor also in terms of circuit constants is explained. The plan is to consider a uniform circular motion point in its path around a circle of a properly chosen dimension radius vector and to compare the speed of the uniform circular motion point with the speed of its simple harmonic projection point moving along the vertical axis. A.

537.311.6 : 621.315.59 : 621.372.413 : 621.317.331

2882. A MICROWAVE RESONANT CAVITY METHOD FOR MEASURING THE RESISTIVITY OF SEMI-CONDUCTING MATERIALS. J.G.Linhart, I.M.Templeton and R.Dunsmuir.
Brit. J. appl. Phys., Vol. 7, No. 1, 36-8 (Jan., 1956).

A method is described for measuring the resistivity of semi-conductors at centimetre wavelengths. A small spherical or cubic specimen is placed in a cavity resonating in the H_{011} mode, and the reduction in Q due to eddy-current loss in the specimen is measured. The theory given enables the resistivity of the material to be calculated. It is shown that resistivities in the range 0.005 to 10 Ω.cm can be determined. A.

537.312.5

2883. THE PHOTOEFFECT IN METALS. S.V.Vonsovskiĭ, A.V.Sokolov and A.Z.Veksler.
Uspekhi fiz. Nauk, Vol. 56, No. 4, 477-530 (1955). In Russian.

A conventional treatment of the theoretical aspects of the problem starting with the ideas of R.H.Fowler and proceeding to the semiphenomenological theory and the quantum-mechanical theory of the photoeffect in metals. Also discussed are the surface effect in ordered alloys and the photoelectric effect in ferromagnetic metals. 65 refs. C.R.S.Manders

537.312.5

2884. PHOTO-EFFECTS IN CONDENSED AROMATIC HYDROCARBONS. D.C.Northrop and O.Simpson.
Proc. Phys. Soc. B, Vol. 68, Pt 11, 974-7 (Nov., 1955).

Photoconductivity of anthracene is quenched by impurities which quench luminescence, but not by impurities which do not affect the emission. Changes in effective dielectric constant occur on illumination but are less affected by impurities. The threshold for the effects coincides with that for matrix absorption. G.F.J.Garlick

537.312.5

2885. PHOTOCONDUCTIVITY OF THE SULFIDE, SELENIDE, AND TELLURIDE OF ZINC OR CADMIUM. R.H.Bube.
Proc. Inst. Radio Engrs, Vol. 43, No. 12, 1836-50 (Dec., 1955).

The highlights of recent photoconductivity research on evaporated, power, and sintered layers, and on single crystals of photoconductors in the group ZnS, CdS, ZnSe, CdSe, ZnTe, and CdTe are reviewed. The following aspects of photoconductivity are discussed: spectral response, impurity sensitization, electrode contact problems, conductivity, mobility, speed of response, photocurrent v. light intensity, photocurrent v. temperature, infrared quenching, thermally stimulated current and trapping, space-charge limited current, photoconductivity and luminescence, photovoltaic effect, photoemissive effect, and surface photoconductivity. The utility of the concepts of the Fermi-level and demarcation-level in the description of many photoconductivity phenomena is briefly discussed. 118 refs. A.

537.312.5

2886. PERFORMANCE OF PHOTOCONDUCTORS. A.Rose.
Proc. Inst. Radio Engrs, Vol. 43, No. 12, 1850-69 (Dec., 1955).

A phenomenological analysis of the processes whereby the conductivity of a material is increased by exposure to radiation. 54 refs. A.

537.312.5

2887. LEAD SALT PHOTOCONDUCTORS. T.S.Moss.
Proc. Inst. Radio Engrs, Vol. 43, No. 12, 1869-81 (Dec., 1955).

Discusses the fundamental basis of photoconductivity in lead sulphide, telluride, and selenide, and its application in modern highly sensitive infrared detectors. The first section deals with the manufacture of cells and the processing of photosensitive layers; and with the characteristics of the final detectors, such as response time, sensitivity, and spectral distribution of sensitivity. The factors determining the maximum attainable sensitivity are discussed. The second section covers fundamental semiconducting properties of the three materials, including absorption, activation energies, carrier lifetimes and effective masses; and the theory of photoeffects in layers. Some applications of these detectors are described. 130 refs. A.

537.312.5

2888. MODIFICATIONS TO THE SPECTRAL SENSITIVITY CURVE OF SELENIUM PHOTOCELLS CAUSED BY TEMPERATURE VARIATIONS. G.Blet.
C.R. Acad. Sci. (Paris), Vol. 242, No. 1, 95-8 (Jan. 4, 1956). In French.

The results of measurements of spectral sensitivity for very weak signals are described for temperatures from 300° K to the helium range. In general the sensitivity for a given wavelength diminishes for decreasing temperature and the diminution is greater for the shorter wavelengths. The changes as described above are reversible. Other results are more complex. C.A.Hogarth

537.312.5

2889. THE PHOTODIANODE: MODULATION OF THE DIFFERENTIAL CURRENT BY AN ALTERNATING MAGNETIC FIELD. L.Deloffre, E.Pierre and J.Roig.
C.R. Acad. Sci. (Paris), Vol. 242, No. 1, 98-100 (Jan. 4, 1956). In French.

The differential current of a photodianode mounted in a bridge circuit measures the displacements of a light spot at the cathode. The system also enables slow variations in luminous intensity of a fixed light spot incident on the cathode to be followed. Magnetic modulation using a field of about 200 oersted provides a convenient measuring technique. C.A.Hogarth

537.312.5

2890. INFRARED RESPONSE OF PYROLYZED ORGANIC FILMS. J.F.Andrew.
J. Opt. Soc. Amer., Vol. 46, No. 3, 209-14 (March, 1956).

The results of studies of the dependence of the photoresponse of films prepared by pyrolysis of cellophane and polyacrylonitrile (Orlon) films on the dark current, wavelength, temperature, construction details of cell mounting, and intensity and frequency of illumination are reported. Films heat treated to 600° C have an energy gap between the full band and the conduction band of about 0.25 eV and a resistivity of approximately 10^4 ohm-cm. The infrared response decreases quite sharply at the limit of the electronic absorption band (at about 5 microns). However, a photoresponse is also found for longer wavelengths in regions of strong molecular vibrational absorptions. The time constant of the photoresponse of the films is found to be the same in both the regions of electronic absorption and of the vibrational absorption. A decrease in time constant with increase in heat dissipation is observed. It is concluded that the photoresponse of the films studied is of a thermistor-bolometric nature. A.

537.312.5 : 538.639

2891. PHOTOCONDUCTIVE AND PHOTOELECTROMAGNETIC EFFECTS IN InSb. S.W.Kurnick and R.N.Zitter.
J. appl. Phys., Vol. 27, No. 3, 278-85 (March, 1956).

Photoconductive (PC) and photoelectromagnetic (PEM) effects have been observed in p-type InSb single crystals of high purity at 77° K (extrinsic range). Because of the large electron mobilities in InSb, and because the variation of the PEM response with magnetic field was found to be strongly dependent on surface treatment, it was necessary to develop a new theoretical model to describe the PEM effect, permitting the evaluation of bulk lifetime and both electron and hole mobilities. In addition, the model affords an interpretation of Hall and magnetoresistance effects in intrinsic InSb. When the PEM effect is analysed using impurity or thermal scattering, assuming Boltzmann statistics, the result does not fit the data so well as the simple model presented here. A.

537.312.5 : 621.383.4

2892. REDUCTION OF NOISE IN PHOTOCONDUCTIVE CELLS. R.E.Burgess.
Brit. J. appl. Phys., Vol. 6, No. 11, 385-7 (Nov., 1955).

The factors determining the signal/noise ratio of photoconductive cells are briefly discussed and attention is drawn to the importance of the noise generated at the electrode contacts when current is flowing through the cell. Means are described for reducing or eliminating this component of noise by means of potential probes near the electrodes combined with suitable external circuits. A.

537.312.62

2893. ON FRÖHLICH'S ONE-DIMENSIONAL MODEL OF A SUPERCONDUCTOR. H.Haken.
Z. Naturforsch., Vol. 11a, No. 1, 96-8 (1956). In German.

The wave functions chosen by Fröhlich (Abstr. 6627/1954) are criticized, and it is shown that more exact solutions are given by linear combinations of such functions. Using these, the energy of a current-carrying state is found to differ considerably from Fröhlich's result, and the matrix element to the ground state does not vanish. R.G.Chambers

537.312.62

2894. ON THE THEORY OF SUPERCONDUCTIVITY. V.L.Ginzburg.
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1234-50 (Dec., 1955).

Macroscopic theory of superconductivity valid for magnetic fields of arbitrary magnitude and the behaviour of superconductors in weak high frequency fields are discussed. The problem of formulating a microscopic theory of superconductivity is also considered. A.

537.312.62

2895. PARAMAGNETIC EFFECT IN SUPERCONDUCTORS. II. FURTHER THEORETICAL ASPECTS. H.Meissner.
Phys. Rev., Vol. 101, No. 1, 31-6 (Jan. 1, 1956).

An investigation is made to determine how the theory of the paramagnetic effect which was developed in Pt I (Abstr. 4681/1955) joins the two limiting cases of $\varphi_0 \to 0$ and $\varphi_0 \to \infty$, where $\varphi_0 = H_{\varphi 0}/H_{z0}$. While the theory joins smoothly to what one would expect for $\varphi_0 \to 0$ (external magnetic field only) it does not join so smoothly in the limit $\varphi_0 \to \infty$ (current only). This, however, shows that London's theory is an ideal limit which cannot be practically realized, so that the current density at r = 0 will in practice always remain finite. A discussion of Scott's experiments on the current transition of thin wires gives valuable information as to where the present theory has to be amended in order to obtain the — so far empirical — correction factor $1 - I_g/I$. This discussion supports on the whole the ideas which were given in this connection in Pt I. A calculation of the apparent relative permeability $\breve{K}_m$ at points other than the peak provides good agreement with experiment for higher currents, but a large discrepancy for the lowest current. This calculation tests whether the assumption of an intermediate core surrounded by a normal conducting cylinder is correct rather than the theory itself. A.

537.312.62

2896. THE PHASE TRANSITION IN SUPERCONDUCTORS. A.B.Pippard.
Physica, Vol. 22, No. 2, 99-102 (Feb., 1956).

By analysing a simple model of a superconductor it is shown that Van der Leeden's conjecture (Abstr. 8719/1955) of a double-point belonging to the class D (1, 1) on the transition line is probably not correct. Instead it appears that the transition lines for positive and negative magnetic fields are continuous in all their derivatives at the transition temperature T_c, but that just below T_c the transition line has a discontinuity of curvature where a critical point marks the change from second-order to first-order transitions. The critical point should only be detectably different from T_c for very small specimens. A.

537.312.62 : 536.48 : 530.162

CONNECTION BETWEEN SUPERFLUIDITY AND SUPERCONDUCTIVITY. See Abstr. 1870

537.312.62 : 537.311.4

2897. MEASUREMENTS OF CONTACT RESISTANCE BETWEEN NORMAL AND SUPERCONDUCTING METALS. F.Bedard and H.Meissner.
Phys. Rev., Vol. 101, No. 1, 26-30 (Jan. 1, 1956).

The contact resistance between crossed wires of Pb and Sn, Pb and Cu, Sn and Cu, Sn and In separated by their natural oxide layers has been measured at constant temperatures as a function of current direction and magnitude. Plots of these measurements in the case of a normal and a superconducting element show the resistance at low currents to be constant and to increase suddenly above a critical current. The low current resistance generally decreased with decreasing temperature. Calculation of the radius of the current-bearing area gives radii of atomic dimensions and shows that in some cases part of the barrier resistance disappears. Furthermore, four contacts showed an immeasurably small resistance at a temperature where only one of the contact members was superconducting. These measurements and earlier ones by others suggest a schematic representation of the resistance as a function of current and temperature. No significant rectification between normal conductors and superconductors was observed. A.

537.312.62 : 537.311.62

2898. THE SURFACE RESISTANCE OF NORMAL AND SUPERCONDUCTING TIN AT 36 kMc/s. E.Fawcett.
Proc. Roy. Soc. A, Vol. 232, 519-37 (Nov. 22, 1955).

A new calorimetric method has been developed to measure the surface resistance of plane single crystals of tin at 36 kMc/s. The normal resistance depends upon the orientations of the tetrad and dyad axes relative to the surface of the specimen and the direction of current flow in the surface, the form of the anisotropy being in good agreement with Pippard's results for cylindrical single crystals of tin at 9.4 kMc/s. The frequency-dependence of the resistance differs rather from that expected for a metal under extreme anomalous conditions, and similar discrepancies are found when the results for specimens of copper and aluminium are compared with earlier work on these metals. Electron micrographs of the electropolished surfaces of the tin specimens show that the anisotropy of the resistance is not merely a surface effect, hence justifying its interpretation as a property of the bulk metal. A simple ellipsoidal model, which constitutes a convenient picture of a surface having certain geometrical characteristics in common with the actual Fermi surface of tin, is found to reproduce the principal features of the anisotropy. The temperature variation of the superconducting resistance may be described by the empirical functions used by Pippard to reduce his results, the shapes of the corresponding curves over certain ranges of temperature for different specimens at the two frequencies being similar, apart from orientation-dependent and frequency-dependent scaling factors. For specimens of different orientations the scaling factors are found to be proportional to each other and to the surface conductance in the normal state, and their ratio is independent of frequency. These results and the form of the frequency-dependence of the superconducting resistance confirm Pippard's conclusion that the observed behaviour at high frequencies is difficult to reconcile with a "two-parameter two-fluid" model of a superconductor. A.

537.32 : 537.312.5

2899. THERMOELECTRIC MEASUREMENTS ON ILLUMINATED LEAD SULPHIDE. H.A.Müser.
Z. Phys., Vol. 144, No. 1-3, 56-65 (1956). In German.

Experiments on PbS/metal assemblies show that once photovoltaic effects are allowed for, the thermoelectric power does not vary with illumination. C.A.Hogarth

537.323 : 537.311.31

2900. THERMOELECTRIC POWER AND ELECTRICAL RESISTIVITY OF DILUTE ALLOYS OF Mn, Pd AND Pt IN Cu, Ag AND Au. F.A.Otter, Jr.
J. appl. Phys., Vol. 27, No. 3, 197-200 (March, 1956).

Data are given on the resistivities and thermoelectric powers of the alloys Cu–Pd, Ag–Pd, Au–Pd, Cu–Pt, Ag–Pt, Au–Pt, Cu–Mn, Ag–Mn and Au–Mn from −195° C to +500° C for the resistivities and to +650° C for the thermoelectric powers. The resistivities of the alloys containing Pd and Pt obey the Matthiessen rule well whereas those with Mn do not. The resistivity of the alloys with more than about 8 atomic % Mn deviate from linearity at the lower temperatures, the temperature of deviation increasing with Mn content. The thermoelectric powers of the Pt and Pd alloys are negative relative to the pure solvents and are reasonably constant relative to the solvents at high temperatures. The thermoelectric powers of the Mn alloys become positive relative to the solvents above certain temperatures (25° C for Cu–Mn, −170° C for Ag–Mn, and 150-250° C for Au–Mn). A brief discussion of the data in relation to theory is given. A.

ELECTRIC DISCHARGES 537.52

537.523.5

2901. THE ANODE MECHANISM IN THERMAL ARGON ARCS. G.Busz-Peuckert and W.Finkelnburg.
Z. Phys., Vol. 144, No. 1-3, 244-51 (1956). In German.

Describes measurements of anode fall voltages by probes and by a study of anode heat dissipation in arcs carrying up to 200 amps and having lengths varying up to 1 cm. At low currents an arc contraction was noticed. The data are discussed. J.D.Craggs

537.523.5 : 537.527.5

2902. A CHAMBER FOR HIGH-CURRENT ARCS IN VARIOUS GASES. H.Maecker.
Z. Naturforsch., Vol. 11a, No. 1, 32-4 (1956). In German.

Describes a new form of arc chamber for high-current (100 A) work in various gases. The arc channel in constrained locally at two points where it passes through narrow holes in the chamber walls. The effect of the constructions on plasma properties ("streaming" etc) is discussed. Typical spectra are given. J.D.Craggs

537.525.3

2903. TEMPERATURE AS A DETERMINANT OF THE CURRENT UNDER ELECTRODELESS DISCHARGE. S.R.Mohanty.
J. chem. Phys., Vol. 24, No. 1, 167 (Jan., 1956).

Describes studies of high voltage a.c. corona in ozonizer tubes. The present experiments deal with temperature variation of discharge current (20-120° C) in oxygen at 48 mm Hg pressure. J.D.Craggs

537.525.5

2904. VACUUM ARCS IN TRANSVERSE MAGNETIC FIELDS. G.Müller and R.Patzelt.
Naturwissenschaften, Vol. 42, No. 24, 642-3 (1955). In German.

A brief note describing observations on the cathode spot movements in low-pressure ($\sim 2 \times 10^{-5}$ mm Hg) arcs in transverse magnetic fields (0-1400 oersteds). Photographs of spot movement are shown. Reference is made to "anomalous" (counter-Lorentz) spot movement. J.D.Craggs

537.525.6

2905. ION OSCILLATIONS IN A CATHODE POTENTIAL MINIMUM. K.G.Emeléus and N.R.Daly.
Proc. Phys. Soc. B, Vol. 69, Pt 1, 114-15 (Jan., 1956).

A relation between noise frequency ν and current I in a hot cathode low-pressure gas discharge which agrees with observations ($\nu \propto I^{\frac{1}{2}}$) is derived. C.G.Morgan

537.525.8

2906. DISAPPEARANCE OF ADSORBED GASES FROM DIELECTRIC SURFACES UNDER ELECTRODELESS DISCHARGE. S.R.Mohanti.
Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 1107-9 (Nov., 1955).

Describes the temporal variations of the characteristics of high voltage electrodeless a.c. corona discharges in ozonizer tubes (100-300 mm Hg of pure oxygen), and relates these variations to changes in surface conditions in the tubes. J.D.Craggs

537.525.8

2907. A STUDY OF INDUCED [ELECTRODELESS] DISCHARGES IN THE RARE GASES. F.Cabannes.
Ann. Phys. (Paris), Vol. 10, 1026-78 (Nov.-Dec., 1955). In French.

This detailed paper describes and discusses experimental work on électrodeless discharges, mainly induced by an external solenoid, shielded electrostatically from the discharge. The frequencies were about 1 Mc/s, and the pressure range was from about 5×10^{-2} to about 15 mm Hg. The gases used were Ne, A, Kr and Xe. Power dissipation in the discharge was measured with a calorimeter. Breakdown characteristics are given. The theoretical treatment includes a discussion of the conductivity of the discharges, of the power dissipation, electron temperatures etc. Double floating probes were used to obtain some of the required data. J.D.Craggs

537.525.8

2908. NOTE ON POSITIVE ION TRANSIT TIME IN GLOW DISCHARGE TUBES. C.Yeh.
J. appl. Phys., Vol. 27, No. 1, 98-9 (Jan., 1956).

The frequency with which the impedance of a discharge changes from inductive to capacitive can be related to the transit time of ions in the cathode fall region. A physical explanation is given, and developed analytically. The data used were obtained with A, Ne and He at pressures of 10-60 mm Hg. J.D.Craggs

537.525.8

2909. ON THE THEORY OF HIGH FREQUENCY DISCHARGES IN LOW-PRESSURE GASES: DETERMINATION OF THE BREAKDOWN CONDITIONS. J.Salmon.
J. Phys. Radium, Vol. 17, No. 1, 33-6 (Jan., 1956). In French.

See Abstr. 6179 (1955) for earlier relevant work. Discusses the breakdown conditions for "electrodeless" discharges, for frequencies varying up to 100 Mc/s and for a pressure range of about 1-50 x 10^{-3} mm Hg. Secondary emission effects etc. are treated, with reference to certain earlier papers. J.D.Craggs

537.525.8

2910. DIFFUSION OF METASTABLE MERCURY MOLECULES. A.O.McCoubrey and C.G.Matland.
Phys. Rev., Vol. 101, No. 2, 603-5 (Jan. 15, 1956).

The band radiation observed in the afterglow of mercury vapour has previously been interpreted in terms of metastable diatomic mercury molecules $Hg_2(^3O_u^-)$. To account for an anomalous density dependence of the diffusion loss observed for these molecules, it was found necessary to assume that the molecules are almost totally reflected at the glass wall boundaries. In the present measurements taken with both glass and molybdenum boundaries, under more careful conditions, the anomalous behaviour was shown to be spurious; the data obtained are consistent with the hypothesis that the $Hg_2(^3O_u^-)$ molecules are completely destroyed upon diffusion to the boundaries. The experimental method is that used in the previous work, in which $Hg_2(^3O_u^-)$ molecules are created as a consequence of the absorption of 2537 A resonance radiation. The time variation of the concentration of molecules is obtained during the afterglow by measuring the intensity of band radiation. The vapour temperature is held constant at 200° C. The product of the diffusion coefficient and mercury vapour density obtained from this work is $ND_M = 63 \times 10^{-16}$ $(atoms/cm^3).cm^2/sec$. These experiments, which include two different geometries and which extend over a wider density range than heretofore, have also yielded a more accurate value for the three-body collision-induced radiation rate, $C_M = 29 \times 10^{-32}$ $(atom/cm^3)^{-2}.sec^{-1}$, and for the spontaneous radiation rate $B = 36\ sec^{-1}$. A.

537.525.8

2911. DEPENDENCE OF JOSHI EFFECT ON THE FREQUENCY OF THE APPLIED VOLTAGE. M.B.Deshmukh.
J. chem. Phys., Vol. 24, No. 2, 472-3 (Feb., 1956).

Briefly describes the effect of frequency variations (25-1000 c/s) of the applied voltage in a.c. electrodeless corona discharges in air-Hg vapour. J.D.Craggs

X-RAYS 537.531

537.531 : 535.33

2912. A RESOLUTION CONDITION FOR X-RAY SPECTRAL LINES. A.N.Nigam.
Indian J. theor. Phys., Vol. 2, No. 4, 175-8 (Jan., 1955).

A general condition for resolution of two X-ray lines of unequal intensities and breadths has been deduced. A.

537.531 : 535.343

2913. THE SPECTRAL DISTRIBUTION IN THE REGIONS OF CHARACTERISTIC (PROPRE) ABSORPTION FOR VARIOUS CRYSTALS. Y.Cauchois.
C.R. Acad. Sci. (Paris), Vol. 242, No. 1, 100-2 (Jan. 4, 1956) In French.

It is shown that perturbations occur in the intensity of X-rays reflected from the crystal of a spectrometer at those wavelengths corresponding to the absorption edges of the elements constituting the crystal. A qualitative explanation is suggested. J.Hughes

537.531 : 535.343

2914. THE $M_{IV,V}$ SPECTRA OF ^{68}Er. E.A.Stewardson and J.E.Wilson.
Proc. Phys. Soc. A, Vol. 69, Pt 2, 93-101 (Feb., 1956).

The M_{IV} and M_V absorption spectra of Er_2O_3 have been studied in detail and a careful comparison made with the $M\alpha,\beta$ emission lines. The M_V absorption spectrum possesses a number of well-defined absorption maxima. It is shown that the minima between these maxima coincide closely with components of the $M\alpha$ multiplet and it is suggested that the main components of the emission line previously observed by Van der Tuuk and by Lindberg are not real but are produced by self-absorption in the target material. The line is probably accompanied by one or more real satellites however. The M_{IV} absorption spectrum is much weaker, but probably possesses a number of maxima also. The $M\beta$ emission line probably possesses a satellite, but its form appears to be influenced by self-absorption. A.

537.531 : 535.345

2915. SOFT X-RAY ABSORPTION OF THIN FILMS OF IRON AND IRON OXIDE. D.E.Carter and M.P.Givens.
Phys. Rev., Vol. 101, No. 5, 1469-72 (March 1, 1956).

The absorption of thin films of iron and of iron oxide has been studied in the wavelength region 170 to 340 A. The absorption edge of iron was found to be at 225 A, while that of iron oxide was at 218 A. A.

537.531 : 535.822.9

2916. HIGH-RESOLUTION X-RAY PROJECTION MICROSCOPY. W.C.Nixon.
Proc. Roy. Soc. A, Vol. 232, 475-85 (Nov. 22, 1955).

The X-ray shadow projection microscope has been limited previously to a resolution of 0.5 micron. A resolution of 0.1 micron has now been achieved with the same exposure time of 5 min. This has been done by using a very thin gold-leaf X-ray target (0.1 micron thick) to avoid enlargement of the point source of X-rays due to electron scattering in a thick target. Electron lens abberations such as astigmatism and spherical aberration are considered but dismissed as possible limitations on X-ray microscope resolution. This improved resolution is tested by observing Fresnel edge diffraction fringes 0.1 micron wide, and this fringe width method is suggested as a resolving power test for all X-ray microscopes. An X-ray micrograph of gold-shadowed bull spermatozoa, tails 0.3 micron diameter, shows this resolution with an actual biological specimen. Finally, electron-induced contamination on test grids has been observed at atmospheric pressure due to electrons penetrating this thin gold-leaf target. A.

CATHODE RAYS. POSITIVE RAYS 537.533/534

537.533

2917. IRROTATIONAL ELECTRON BEAMS. J.Coste and J.L.Delcroix.
C.R. Acad. Sci. (Paris), Vol. 242, No. 2, 236-8 (Jan. 9, 1956). In French.

In monokinetic, irrotational (curl v = 0) electron beams a general expression can be given for the space-charge in terms

of the velocity. The result is a second-order nonlinear differential equation. A.H.W.Beck

537.533

2918. GAS SCATTERING IN A STRONG FOCUSING ELECTRON SYNCHROTRON. M.J.Moravcsik and J.M.Sellen, Jr.
Rev. sci. Instrum., Vol. 26, No. 12, 1158-64 (Dec., 1955).

Scattering of the electron beam by the residual gas in the vacuum chamber is calculated for the 1 BeV strong focusing Mesotron. It is shown that the elastic scattering by the nucleus and the inelastic scattering by the atomic electrons are the only important contributions to the loss due to the presence of gas. These two effects are calculated in detail. Radiation and space charge effects are not discussed. Because of the small scattering angles involved the details of the screening by the atomic electrons must be taken into account accurately. Multiple scattering is shown to be of little importance because of the damping of the beam oscillations as the energy increases. The calculations are carried out for two different injection conditions and little difference is found between them as far as the loss due to the scattering itself is concerned. The numerical results for the Mesotron show that about half of the beam gets lost at a vacuum of 5×10^{-6} mm Hg. The scattering losses will depend on the field lattice of the synchrotron. A.

537.533 : 537.534

2919. SYNCHROTRON OSCILLATIONS IN STRONG-FOCUSING ACCELERATORS. (LINEAR THEORY).
L.L.Goldin and D.G.Koškarev.
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1251-68 (Dec., 1955).

Equations describing the oscillations are deduced and solved. In deriving them it was taken into account that the accelerating field frequency is automatically connected with the magnetic field intensity. A general solution for oscillations both in the adiabatic and critical regions has been found, and respective integrals of motion have been obtained. It is shown that motion in the critical region may be simply represented by the "effective frequency" of oscillation. The paper investigates the influence of the fluctuations, ripples and noise of the frequency and amplitude of the accelerating voltage and magnetic field. Computation formulae are given for respective tolerances. A.

537.533.2

2920. RESEARCHES ON THE TEMPERATURE DEPENDENCE OF THE ELECTRON WORK FUNCTION OF METALS AND SEMICONDUCTORS. O.Böttger.
Z. Phys., Vol. 144, No. 1-3, 269-95 (1956). In German.

The work function was determined from the contact p.d. For metals (Cu and Ni) values were obtained as functions of time after glowing, temperature and vacuum conditions. In the case of n- and p-type copper oxide and p-type nickel oxide, owing to the breakdown to metal when glowed in vacuum only the temperature dependence of ϕ was determined. For Cu and Ni in good vacuum (10^{-8} mm Hg) the temperature coefficient of ϕ is less than 2×10^{-5} eV/degree. A.H.W.Beck

537.533.3

2921. THE AMPLITUDES OF THE WAVE FIELD IN ELECTRON INTERFERENCE IN THE LAUE CASE. H.Niehrs and E.H.Wagner.
Z. Phys., Vol. 143, No. 3, 285-99 (1955). In German.

The usual method for calculating the amplitudes is reviewed. It involves the solution of a non-homogeneous system of equations. In the Laue case it is shown how the method may be shortened by modifying the matrix of coefficients of the equations. The method, in a special case, has already been used (Abstr. 5929/1951). L.S.Goddard

537.533.3 : 621.385.833

2922. FOCUSING OF ELECTRON BEAMS BY MAGNETIC FIELDS. W.Kleen and K.Pöschl.
Arch. elekt. Übertragung, Vol. 9, No. 7, 295-8 (July, 1955).
In German.

If in a cylindrical electron beam focused by longitudinal magnetic fields the boundary electrons are slightly oscillating about a mean radius, a simplified method can be developed for obtaining this radius and the maximum deviation from it. The results apply to general initial conditions at the cathode and to constant as well as to periodic magnetic focusing fields. A.

537.533.35

2923. ON THE MAGNIFICATION AND RESOLUTION OF THE FIELD EMISSION ELECTRON MICROSCOPE. D.J.Rose.
J. appl. Phys., Vol. 27, No. 3, 215-20 (March, 1956).

The resolution of the field emission electron microscope is expressed as a function of the ratio of its magnification M to the time-of-flight τ of an electron from emission tip to screen. It is shown that small protrusions on the surface of the tip can provide areas for which M is much greater than that computed for a perfectly smooth tip. Resolution of the order of 3 A is possible on these protrusions, so that some of their atomic detail should be observable. A.

537.533.35

2924. A FAVORABLE CONDITION FOR SEEING SIMPLE MOLECULES IN A FIELD EMISSION MICROSCOPE.
J.A.Becker and R.G.Brandes.
J. appl. Phys., Vol. 27, No. 3, 221-3 (March, 1956).

The intensely bright doublets sometimes observed in field emission microscopes vary in size, shape, intensity, and resolution. It is proposed that these doublets are owing to simple small molecules adsorbed on tungsten protrusions or ridges on the tungsten tip covered with a chemisorbed layer of residual gas. The variation in the doublets is ascribed to variation in the size and shape of the protrusions as predicted by a theory developed by D.J.Rose (see preceding abstract). A.

537.533.35 : 539.165.08

2925. A SEMI-CIRCULAR BETA-RAY SPECTROMETER FOR BETA-GAMMA COINCIDENCE MEASUREMENTS.
E.F.de Haan and G.J.Sizoo.
Physica, Vol. 21, No. 10, 818-28 (Oct., 1955).

A semi-circular beta-ray spectrometer for coincidence measurements and the associated homogeneous magnet are described. Some operating data are given including that relevant to the measurement of branching ratios. A.

537.533.35 : 621.316.721

2926. A VOLTAGE REGULATOR SYSTEM FOR STABILIZATION OF FIELD CURRENT OF A SOLENOIDAL BETA-RAY SPECTROMETER. J.Mahanty and A.N.Prasad.
J. sci. industr. Res., Vol. 13B, No. 7, 461-3 (July, 1954).

An experimental procedure for stabilizing magnetizing current in a beta-ray spectrometer using an electronically regulated d.c. generator is described. A.

537.533.74

2927. SCATTERING OF 200-keV ELECTRONS IN GOLD.
W.G.Pettus, H.G.Blosser and F.L.Hereford.
Phys. Rev., Vol. 101, No. 1, 17-18 (Jan. 1, 1956).

The relative differential cross-sections for scattering of 200 keV electrons by gold foils have been measured and compared to values computed from the Mott theory. The 70^0 to 150^0 angular range was covered. The data are in satisfactory agreement with theory and fail to show discrepancies previously reported. A.

537.533.74

2928. THE MULTIPLE SCATTERING OF 4.5 MeV ELECTRONS. F.F.Heymann and R.E.Jennings.
Proc. Roy. Soc. A, Vol. 234, 116-24 (Jan. 24, 1956).

The multiple scattering of 4.5 MeV electrons by foils of aluminium, copper, molybdenum, silver and platinum has been

determined, using a photographic method to measure the variation of scattered electron intensity with angle. It was found that the results were in good agreement with the Molière theory into the region of plural scattering, this being the upper limit of angles covered by the observations. A.

537.533.74

2929. THE SCATTERING OF FAST CHARGED PARTICLES. I. ON THE SINGLE SCATTERING OF 13.5 MeV ELECTRONS IN XENON. K.R.Allen, M.M.Lipsicas, D.Major and K.Phillips.

Proc. Phys. Soc. A, Vol. 69, Pt 2, 141-52 (Feb., 1956).

The scattering of fast electrons with a mean energy of 13.5 MeV has been investigated. Approximately 3000 stereoscopic pairs of photographs were obtained with a Wilson cloud chamber filled with xenon and helium using a 20 MeV betatron as the source of high energy electrons. A total length of corrected track of 1270 metres yielded 318 scatters greater than 5^0. Comparison of these results with the Rutherford scattering gives a ratio which varies from unity at 0^0 to a maximum of 1.6 between 20^0 and 30^0. An inverse square law dependence of scattering with energy is found. General agreement, within the statistical limits of the experiment, is obtained with the theoretical cross-sections of Curr, McKinley and Feshbach, and Bartlett and Watson. A.

537.533.75 : 537.531

2930. COMPARISON OF THE CHARACTERISTIC ENERGY LOSSES OF ELECTRONS WITH THE FINE STRUCTURE OF THE X-RAY ABSORPTION SPECTRA. L.B.Leder, H.Mendlowitz and L.Marton.

Phys. Rev., Vol. 101, No. 5, 1460-7 (March 1, 1956).

Comparison of the characteristic energy losses of electrons in several materials with the fine structure found on the short-wavelength side of the X-ray K-absorption edge indicates that there is a correlation between the two phenomena. This leads to the belief that many of the characteristic energy losses may be due to excitation of the valence electrons to higher allowed energy levels. It is also shown that, in general, the energy-loss spectra are similar for metals which are neighbours in the periodic table, and that there is some dependence on the crystal lattice constant. A.

537.533.75 : 537.534.75

2931. TRANSPORT OF ENERGY BY KNOCK-ON ELECTRONS. J.W.Gardner.

Proc. Phys. Soc. A, Vol. 68, Pt 11, 1072-7 (Nov., 1955).

The effect of knock-on electrons on the ionization loss of a primary particle within a given layer of a material is calculated. This shows that a correction is necessary in the normal value of energy loss of the order of one or two per cent for the chosen case. The effect of knock-on particles on energy-loss distributions is shown qualitatively as likely to be important at least for the high-energy tail of the curve.

A.J.Egginton

537.533.8

2932. BREMSSTRAHLUNG DIFFERENTIAL CROSS-SECTION MEASUREMENTS FOR 0.5- AND 1.0-MeV ELECTRONS. J.W.Motz.

Phys. Rev., Vol. 100, No. 6, 1560-71 (Dec. 15, 1955).

The bremsstrahlung cross-section, differential in photon energy and angle, has been determined by measuring the X-rays emitted from thin targets of beryllium, aluminium and gold, for incident electron energies of 0.5 and 1.0 MeV, with a 5 in. dia., 4 in. long NaI (Tl) scintillation spectrometer at angles of 0, 10, 20, 30, 60, 90 and 120 degrees. The results show that in this energy region, the Bethe–Heitler–Sauter (Born approximation) theory underestimates the cross-section. A comparison of the cross-section for beryllium and aluminium gives evidence for electron–electron bremsstrahlung. The experimental values for the Heitler parameter ϕ_{rad}/ϕ $(1 + 1/Z)$ are 8.8 for beryllium and 8.4 for aluminium at 1.0 MeV and 6.8 for aluminium at 0.5 MeV. The accuracy of these values is estimated to be better than 20%. The corresponding Bethe–Heitler values for ϕ_{rad}/ϕ are 6.5 at 1.0 MeV and 5.5 at 0.5 MeV. A.

537.533.8

2933. ANGULAR DISTRIBUTION OF BETATRON TARGET RADIATION. A.Sirlin.

Phys. Rev., Vol. 101, No. 4, 1219-26 (Feb. 15, 1956).

An attempt is made to combine the bremsstrahlung intrinsic energy–angle distribution for radiated photons with Molière's multiple-scattering theory for the incident electrons. The angular distribution of betatron radiation is essentially characterized by a function $I(\theta)$, which is given as a series in inverse powers of Molière's parameter B. The first term of this expansion, which is dominant for small angles, is equivalent to a combination theory developed on the basis of a Gaussian approximation for multiple scattering. This term is worked out exactly and its final expression may be compared with previous theories which depend upon mathematical approximations. The term of order B^{-1} becomes important for larger angles and gives the transition to the contribution of single-scattered electrons. Expressions for the forward radiation and energy–angle distribution are given. The angular distribution predicted by these results was found to be in good agreement with an experiment performed by Lanzl and Hanson. A.

537.534

2934. MASS SPECTROMETRIC INVESTIGATION OF THE FIELD EMISSION OF POSITIVE IONS. M.G.Inghram and R.Gomer.

Z.Naturforsch., Vol. 10a, No. 11, 863-72 (1955). In German.

This investigation of the positive ions produced at the surface of, and in the neighbourhood of the point of a field emission microscope elucidated the mechanism of the ionisation process and suggested various applications. These latter consist in a determination of the dissociation products in chemisorption, the analysis of gas mixtures, the detection and measurement of short-life intermediate products, free radicals and so on. J.Hughes

537.534

2935. ABSOLUTE MEASUREMENT OF CYCLOTRON BEAM CURRENTS FOR RADIATION-CHEMICAL STUDIES. R.H.Schuler and A.O.Allen.

Rev. sci. Instrum., Vol. 26, No. 12, 1128-30 (Dec., 1955).

Characteristics are described for the collection of cyclotron beams in a conducting medium separated from the accelerator by an insulating window. The measured current can be interpreted in terms of an absolute beam current if charge displacement within the insulator is taken into account. Collection of the beam in this manner is particularly advantageous in a region external to the cyclotron magnetic field where stray currents due to air ionization and secondary electron emission are pronounced. A comparison is made between particle energies determined by the charge-input method and by calorimetry. A simplified arrangement for particle range determination is described. A.

537.534

2936. AN ANALYSIS OF INJECTION PHENOMENA IN THE BIRMINGHAM PROTON SYNCHROTRON. C.A.Ramm, R.F.Coe and T.B.Vaughan.

J. sci. Instrum., Vol. 33, No. 3, 102-6 (March, 1956).

Experimental analysis of the injection processes in the Birmingham proton synchrotron shows that the machine accepts particles for the whole of the theoretical time of injection and that the radio-frequency system accelerates only those particles with very small betatron oscillations. Injection with rising energy gives an increase of more than twice the intensity of the machine output compared with constant energy injection. A.

537.534 : 621.384.612

2937. THE PRINCIPLES AND APPARATUS OF THE INJECTION SYSTEM OF THE BIRMINGHAM PROTON SYNCHROTRON. C.A.Ramm.
J. sci. Instrum., Vol. 33, No. 2, 52-8 (Feb., 1956).

An outline is given of the principles used in the injection system of the Birmingham proton synchrotron which make the injection process relatively automatic and free from the necessity of a primary proton beam with an energy of great stability. A simple analysis is made of particle collection in the absence of the radio-frequency acceleration. The basic components and methods of monitoring the injection system are described. A.

537.534 : 621.384.61

2938. THE RING PHASOTRON — A NEW ACCELERATOR FOR CHARGED PARTICLES. A.A.Kolomenskiĭ, V.A.Petukhov and M.S.Rabinovich.
Some problems in the theory of cyclical accelerators. Moscow: USSR Academy of Sciences (1955) pp. 7-12. In Russian.

The relative advantages of constant-field and variable-field accelerators are discussed. A new form called the ring phasotron is described, in which alternate sectors have oppositely directed magnetic fields. This surmounts the difficulty that a sharp radial field decrease is necessary for acceleration purposes, whereas only a slight radial decrease is allowable for weak-focusing machines. J.B.Sykes

537.534 : 621.384.61

2939. ON THE POSSIBILITY OF DISPENSING WITH A CRITICAL ENERGY IN AN ACCELERATOR WITH STRONG FOCUSING. V.V.Vladimirskiĭ and E.K.Tarasov.
Some problems in the theory of cyclical accelerators. Moscow: USSR Academy of Sciences (1955) pp. 13-22. In Russian.

It is shown that the critical energy of a strong-focusing accelerator can be raised to infinity by introducing compensating magnets, whose field is opposite to that of the normal magnets, at intervals close to the period of the betatron oscillations. Calculations are given and illustrated by a table. J.B.Sykes

537.534.3

2940. RESOLVING POWER OF FIELD ION MICROSCOPE. E.W.Müller.
Z. Naturforsch., Vol. 11a, No. 1, 88-94 (1956). In German.

A consideration of the operation of the field emission microscope using electrons or ions, taking into account field desorption and ionization, yields a formula for the resolving power of the ion microscope which gives results in agreement with experiment. Cooling of the microscope with solid N_2 or liquid H_2 enables atomic structure to be made visible. W atoms 2.74A apart can be clearly resolved. H.J.H.Starks

537.534.3

2941. APPLICATIONS OF THE OPTICS OF ELECTRIC CHARGES TO MASS SPECTROMETRY. R.Vauthier.
Ann. Phys. (Paris), Vol. 10, 968-1025 (Nov.-Dec., 1955). In French.

Ion optics are investigated for a system using a magnetic field with plane parallel boundaries and an associated (two-dimensional) electrostatic lens. Predicted improvements in resolving power were verified experimentally; a resolution of 155 was obtained with a very open beam. Focus may be adjusted by electrical control of the lens. Ion trajectory calculations inside the ion source (considered as an immersion lens) are outlined; it is predicted that effective size of source is less than that of the analyser entry-slit, and this was confirmed experimentally. The instrument described is primarily designed for isotopic abundance measurements. N.M.King

537.534.3

2942. THIRD-ORDER ABERRATION AND FOCUSING WITH SECTOR-SHAPED MAGNETIC FIELDS. D.F.Dempsey.
Rev. sci. Instrum., Vol. 26, No. 12, 1141-5 (Dec., 1955).

A divergent beam of monoenergetic charged particles can be refocused by a homogeneous magnetic field whose sharply defined boundaries are straight lines or circles. The transverse aberration of order α^3 at the image point is evaluated and a general third-order focusing condition is given. Design equations for third-order instruments are obtained and the results presented graphically. Many third-order focusing designs follow, both symmetrical and asymmetrical. A.

537.534.3

2943. COMPOUND ION-RESONANCE MASS SPECTROMETER. C.F.Robinson.
Rev. sci. Instrum., Vol. 27, No. 2, 88-9 (Feb., 1956).

A new mass spectrometer, which constitutes essentially a low-resolution 180° instrument and a cyclotron in series, is proposed. The instrument appears to have substantial merits in freedom from space charge, discrimination and gas scattering, in signal available, and in the possibility of differential pumping, while retaining the important features that the fine resolution depends only on the instrument parameters and the e/m of the ion involved. A.

537.534.74

2944. POLARIZATION OF HIGH ENERGY PROTONS SCATTERED BY IRON. T.Eriksson.
Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 907-10 (Nov., 1955).

The polarization of protons scattered by iron is calculated at 90, 150, 225 and 400 MeV. The phases are calculated with the so called "optical model". A similar type and strength of the spin-orbit term is assumed to that used by E.Fermi. A.

537.534.74

2945. POLARIZATION OF HIGH ENERGY NUCLEONS SCATTERED BY NUCLEI. S.Köhler.
Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 911-16 (Nov., 1955).

Calculations were made for protons. With spin-orbit coupling similar to that used by E.Fermi one appears to get good agreement, at 135 MeV. At 90 MeV phase-shifts were, for comparison, calculated both in the WKB and the Born approximations. An alternative derivation of the explicit formula for the polarization of neutrons first given by E.Fermi in the Born approximation is outlined briefly. A.

537.533.74

2946. ELASTIC NUCLEAR COLLISIONS OF 1 MeV ELECTRONS IN ARGON. A.Lovati and C.Succi.
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1224-33 (Dec., 1955). In Italian.

The scattering has been analysed by means of a diffusion cloud chamber filled with argon at atmospheric pressure. A total length of 2157 m was measured in about 10 000 photographs, collected in 50 hours. The total number of scatterings $\geq 20^\circ$ is 739, with 56 deflections greater than 50°. The ratio between the experimental and the theoretical total cross-section for angles $\geq 50^\circ$ is 1.02 according to Mott's prediction and 0.84 according to Rutherford's theory. The analysis of the differential cross-sections shows that the formula of Mott is in better agreement with the experimental results than the formula of Rutherford. A.

537.534.74

2947. THE SCATTERING OF PROTONS WITH ENERGIES 460-660 MeV ON PROTONS. S.J.Nikitin, J.M.Selector, E.G.Bogomolov and S.M.Zombkovskij.
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1269-81 (Dec., 1955).

The scattering cross-section and the angular distribution were measured over the range 460 to 660 MeV. The results show that the scattering cross-section is isotropic practically up to proton energies of 460 MeV, but in the interval 560-660 MeV it is markedly anisotropic. A discussion of the results obtained is given. A.

537.534.74

2948. COULOMB INTERFERENCE IN HIGH-ENERGY PROTON-PROTON SCATTERING. A.Garren.
Phys. Rev., Vol. 101, No. 1, 419-23 (Jan. 1, 1956).

The use of Coulomb interference in the phase-shift analysis of p-p scattering is considered. To this end the Coulomb amplitude is calculated relativistically in the Born approximation, using a static anomalous magnetic moment. This amplitude is used to obtain formulae for the Coulomb interference contribution to the cross-section and polarization. An application to the phase-shift analysis of the 200 MeV data is discussed. A.

537.534.74

2949. ANALYSIS OF THE SMALL-ANGLE ELASTIC SCATTERING OF HIGH-ENERGY PROTONS BY CARBON. W.Heckrotte.
Phys. Rev., Vol. 101, No. 4, 1406-9 (Feb. 15, 1956).

The usual treatment of the high-energy elastic scattering of protons by nuclei is extended to include relativistic Coulomb corrections and a complex nuclear spin-orbit potential. With these additions it is possible to obtain a good fit of the experimental results on the polarization of high-energy protons scattered elastically by carbon for small scattering angles. In addition, it is possible to deduce the sign of the nuclear spin-orbit potential from the high-energy data alone. The significance of the imaginary spin-orbit potential is discussed. A.

537.534.74 : 539.185

2950. CHARGE INDEPENDENCE AND POLARIZATION EXPERIMENTS. L.Wolfenstein.
Phys. Rev., Vol. 101, No. 1, 427-8 (Jan. 1, 1956).

Charge independence is applied to experimental data on n-p and p-p scattering around 300 MeV. Results are deduced for the cross-section and polarization for the nucleon-nucleon scattering with total isotopic spin zero. A.

537.534.74 : 778.34

2951. MAGNETIC ANALYSIS OF SCATTERED PARTICLES. H.P.Furth.
Rev. sci. Instrum., Vol. 26, No. 12, 1097-100 (Dec., 1955).

The theory of conditioned probabilities is applied to the problem of momentum, charge, and mass determination from Coulomb scattered tracks in a magnetic field. An optimum procedure is derived, which makes use of both random and systematic track curvature. It is shown that application of this procedure to a highly relativistic nuclear emulsion track of 1 cm length in a field of 300 000 gauss will yield the momentum information of a 9.2 cm track in zero field. If the scattering information were neglected, the effective length of the track would be 8.2 cm. At 100 000 gauss, the improvement in effective track length due to the inclusion of scattering information is shown to be by a factor of 2.3. A.

537.534.75

2952. ESTABLISHMENT OF A SEMI-EMPIRICAL RANGE–ENERGY RELATION FOR COMPOSITE MEDIA. P.Janssens and M.René.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 760-72 (Oct., 1955). In French.

A simple analytical relation giving the range of a heavy charged particle (p, α, ...) as a function of its initial kinetic energy is established. This relation contains two parameters, depending on the medium. The ranges calculated are in agreement with the experimental results; the precision is of 1% at the non relativistic energies, which is comparable with the precision given by Vigneron's method. An approximate relation, more rapidly calculable, gives a precision of 2 or 3%. Curves are established in three media: photographic emulsion, air and aluminium. A.

537.534.75

2953. ENERGY LOSS OF PROTONS PASSING THROUGH HYDROGEN. A.Dalgarno and G.W.Griffing.
Proc. Roy. Soc. A, Vol. 232, 423-34 (Nov. 8, 1955).

The cross-sections of processes involving protons and hydrogen atoms calculated by Bates, Dalgarno and Griffing using the Born approximation are employed to make a detailed analysis of the contributions of excitation, ionization and capture to the stopping power of a gas of atomic hydrogen for a beam consisting initially of protons. A range of beam energies from 10 keV to 3 MeV is covered. The computed total energy loss is compared with experimental data and the accuracy of the Born approximation for heavy particle collisions is discussed. A.

537.534.75

2954. EXPERIMENTAL RELATION BETWEEN RANGE AND ENERGY OF NITROGEN IONS IN NUCLEAR EMULSIONS FOR ENERGIES BETWEEN 10 AND 100 MeV. R.Chaminade, M.Crut, H.Faraggi, A.Garin-Bonnet, J.Olkowsky and A.Papineau.
C.R.Acad. Sci. (Paris), Vol. 242, No. 1, 105-8 (Jan. 4, 1956). In French.

The energies of the nitrogen ions are defined by the curvature of their trajectories in the magnetic field of the Saclay cyclotron and the ranges are measured in Ilford C2 emulsion. The results are compared with theoretical curves and it is found that the measured ranges are larger than expected. Further calculations are in progress. The empirical formula of Barkas fits the data between 35 and 75 MeV but is wrong elsewhere. No mention is made of the moisture or exact chemical composition of the emulsion at the time of irradiation.
D.J.Prowse

DISCHARGE TUBES. COUNTERS 537.54

537.542

2955. NEGATIVE HYDROGEN ION SOURCE. J.A.Phillips and J.L.Tuck.
Rev. sci. Instrum., Vol. 27, No. 2, 97-8 (Feb., 1956).

An r.f. ion source of conventional type is shown to yield a current of 2.2 microamp of negative hydrogen ions. This is accomplished by charge exchange of the positive ions emerging from the plasma with the neutral gas in the probe channel. The negative ion beam is well focused, and the performance of the source is 0.22 microamp/cm^3 at NTP/hour. The differential equations for the above charge exchange process are set down and solved, and found to be consistent with the observations to within an order of magnitude using published cross-sections. The theory also predicts a sizable neutral beam (about 60 microamp) of energy 2-3 keV. According to the equations and the published positive ion performance of these sources, many times larger negative hydrogen ion yields should be obtainable if required. A.

537.542

2956. THERMAL GRADIENT EFFECT IN PROPORTIONAL COUNTERS. C.W.McCutchen.
Rev. sci. Instrum., Vol. 27, No. 2, 106 (Feb., 1956).

Briefly describes experiments on the local variations of gas multiplication of initial ionization in a proportional counter containing A/CO_2. The results agree with predictions.
J.D.Craggs

537.542 : 539.16.08

2957. STATISTICAL SPREAD IN PULSE SIZE OF THE PROPORTIONAL COUNTER SPECTROMETER. A.Bisi and L.Zappa.
Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 988-94 (Nov., 1955).

The pulse size distribution from monoenergetic radiations in a proportional counter was analysed in the energy range between 2 and 70 keV. It is shown that the experimental data on

total relative variances fit strictly to the relation: $\sigma_P/\bar{P} = 0.138/E^{0.398}$ The obtained spreads are smaller than would be according to Poisson's distribution. An attempt is made to deduce the relative variance in the number of initial electrons produced when the total energy of the primary particle is available for useful ionization. A.

537.542 : 548.733

2958. SOME NOTES ON THE DESIGN AND PERFORMANCE OF X-RAY PROPORTIONAL COUNTERS. A.R.Lang.
J. sci. Instrum., Vol. 33, No. 3, 96-102 (March, 1956).

For proportional counting X-ray wavelengths used in diffraction, xenon is the best counter gas, krypton the least suitable. A small, high-efficiency, low-background, xenon-filled counter is described. Argon and xenon counters containing about 10% ethylene operate stably with 50 000-fold multiplication of CuKα ionization, but for undistorted pulse-height distributions at counting rates greater than 10 000 per second multiplication should not be greater than a few thousand. Diffraction pattern background intensity of light elements, such as aluminium, is reduced to $\frac{1}{2}$ to $\frac{2}{3}$ of the value as registered by a Geiger counter. A.

537.542 : 539.172.4 : 621.387.422

2959. NUCLEAR-REACTION-CONTROL IONIZATION CHAMBERS. W.Abson and F.Wade.
Proc. Instn Elect. Engrs, Paper No. 2029 M, publ. March, 1956, 7 pp. To be republished in Vol. 103 B (1956).

The paper describes the design and the electrical characteristics of a neutron-sensitive d.c. ionization chamber suitable for a wide range of applications in nuclear-reactor-control instrumentation systems. Thermal-neutron sensitivities of 10^{-15}-10^{-14} A/n/cm^2/sec can be obtained using boron trifluoride filling or boron-coated electrodes with hydrogen filling. The corresponding γ-radiation sensitivities are of the order of 10^{-12}-10^{-11} A/r/h. Virtually complete collection of the ionization current is possible, up to neutron flux levels of 10^{11}n/cm^2/sec, with a polarizing voltage of a few hundred volts. The residual current due to neutron-induced activities in the chamber falls to less than 10^{-6} times the full-power neutron current some 20 min after shut-down. The siting of ionization chambers has an important bearing on their range of utilization in control-instrumentation systems, and this is discussed briefly in relation to the electrical characteristics of the chambers described. A.

537.542

2960. SIMPLE FALL-OUT METER USES CdS.
C.C.Klick, H.J.Peake, P.T.Cole, H.Rabin and J.J.Lambe.
Nucleonics, Vol. 13, No. 12, 48 (Dec., 1955).

A CdS photoconductivity type crystal detector of gamma-radiation, sensitive in the range 0.1-1000 r/hr, is described. Response to low energy gamma-rays is enhanced by surrounding the crystal with a thin lead sheet and an energy dependence check with 100 and 200 kV X-rays and Co^{60} gamma-rays indicated a fairly uniform response. L.R.Shepherd

537.542

2961. ON THE ENERGY RESPONSE AND RESOLUTION OF A SCINTILLATION COUNTER. S.Dhar.
Indian J. Phys., Vol. 29, No. 7, 329-51 (July, 1955).

Experimental investigations using different phosphors are reported. The observations have been taken with the help of a 180 M-F spectrometer set up as an energy selector and results are obtained for the phosphors NaI—Tl, anthracene, stilbene, terphenyl and plastifluor B (plastic phosphor) under excitation by monoenergetic electrons ranging from nearly 100 keV to 1.1 MeV. From the experimental data, sodium iodide shows a linear behaviour in the entire energy range investigated while anthracene, stilbene and terphenyl seem to give linear responses above 160 keV, 120 keV and 240 keV respectively. The plastic phosphor is non-linear up to about 800 keV. The relative responses of the different phosphors to monoenergetic electrons are obtained under similar experimental conditions. The pulse height distributions for all the phosphors are found to be approximately of Gaussian nature. With the help of experimental data, the figure of merit and the energy required to produce one photon have been calculated for different phosphors. The pulse height resolutions for the phosphors have been computed from the experimental results and the inverse pulse height resolutions are plotted against pulse heights. The relative response curves and the inverse resolution pulse height curves reveal the comparative value and the usefulness of a particular phosphor in the spectrometry of nuclear radiations. A.

537.542

2962. FOR LOW SPECIFIC ACTIVITY: USE SCINTILLATION COUNTING. C.D.Wagner and V.P.Guinn.
Nucleonics, Vol. 13, No. 10, 56-9 (Oct., 1955).

Windowless flow, liquid scintillation, internal gas counters and ionization chambers as detectors of H^3 and C^{14} are compared on the basis of minimum detectable specific activity. The liquid scintillation counter, in which the samples are dissolved in the scintillator is the most sensitive method. Three methods of detecting gamma-emitters, namely crystal well, end-on and dip type NaI scintillation counters are also compared. The dip counter, in which the crystal is immersed in a large volume of liquid, is sensitive to very low concentrations, viz: a fraction of a gamma-ray emitted per min/cm^3.
L.R.Shepherd

537.542

2963. MILLIMICROSECOND TIMING WITH LARGE SCINTILLATION DETECTORS. J.W.Keuffel, W.H.Sandmann and R.K.Stitt.
Rev. sci. Instrum., Vol. 26, No. 12, 1191-5 (Dec., 1955).

The timing precision attainable with large liquid scintillation detectors has been studied. Such detectors have slow rise-times (about 10^{-8} sec) compared with those used in conventional nuclear physics timing experiments. The rise-time is a result of photon time of flight and transit time in the larger, slower photomultipliers (such as the Dumont 6364) which must be used for good light collection. However, timing errors due to rise-time may be largely overcome when dealing with large, statistically smooth pulses such as are encountered in cosmic-ray experiments with unstable particles. A simple correction based on the pulse height is applied to each time measurement. Using this technique a timing error curve is obtained with a standard deviation of 1.6 millimicrosec for a large detector using a Dumont 6364. A.

537.542

2964. LIQUID SCINTILLATORS. I. PULSE HEIGHT COMPARISON OF PRIMARY SOLUTES. F.N.Hayes, D.G.Ott, V.N.Kerr and B.S.Rogers.
Nucleonics, Vol. 13, No. 12, 38-41 (Dec., 1955).

The maximum scintillation pulse heights of 102 different organic solutes in toluene, each at optimum concentration, were determined under excitation by 624 keV internal conversion electrons from Ba^{137} using a DuMont 6292 photomultiplier. The ratio of pulse heights with TiO_2 and Al reflectors covering the solutions were also determined as a spectral index of the emitted light, the TiO_2 being a good reflector for wavelengths greater than 4000 A. The results are tabulated.
L.R.Shepherd

537.542

2965. A LIQUID SCINTILLATOR CONTAINING NITROGEN. J.R.Prescott.
J. sci Instrum., Vol. 33, No. 3, 126 (March, 1956).

It is found that acetonitrile can be loaded with p-terphenyl (with diphenyl hexatriene as a spectrum converter) and will function as a scintillation detector for internal photo-disintegration experiments. Addition of toluene lowers the effective nitrogen content but improves the scintillation efficiency.
G.F.J.Garlick

537.542

2966. SOLID-STATE DETECTOR FOR LOW-ENERGY IONS. O.Heinz, E.M.Gyorgy and R.S.Ohl.
Rev. sci. Instrum., Vol. 27, No. 1, 43-7 (Jan., 1956).

The electrical properties of a polished surface of high-purity silicon can be greatly modified by heavy ion bombardment. In particular, the change in the rectifying properties of silicon has been used as a detector of low energy ions striking the surface. By bombarding with He^+ ions through a silver film which was evaporated directly on the silicon, the thickness of Ag has been determined at which ions no longer reached the silicon surface. By this method it was found that the range of 30 keV He^+ ions in Ag films is 2480 ± 250 A. The lowest ion energy which produces an observable effect on the silicon is about 200 eV. Similar effects have been observed for hydrogen, argon, nitrogen and oxygen ions. Other electrical properties of silicon surfaces which have possibilities as ion indicators are mentioned. A.

537.542

2967. NEW TYPE OF BETA-, GAMMA-RAY DETECTOR. E.W.Godbole.
J. chem. Phys., Vol. 24, No. 1, 166 (Jan., 1956).

A glass tube containing iodine vapour at $\frac{1}{2}$ mm Hg was wound with two external ring electrodes, across which an alternating voltage was applied. Beta- and gamma-rays caused pulses to appear at the earthed electrode, as shown on a c.r.t. The pulses appeared for a range of voltages below 1.6 kV at which a continuous discharge occurs. White light caused a similar response. The dielectric surface and the self-quenching action of the halogen vapour appear to be important, but the properties of the detector remain to be explained, and further work is in progress. D.R.Chick

537.542

2968. HIGH SENSITIVITY AND ACCURACY PULSE TRIGGER CIRCUIT. S.Barabaschi, C.Cottini and E.Gatti.
Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 1042-51 (Nov., 1955).

Describes a high-sensitivity pulse-height selector obtained using a retarding field diode and a differential negative resistance of high stability obtained by means of a multi-electrode electronic tube using the current division between screen grid and anode. The threshold of the discriminator can be set in the range of 1 to 30 mV, its stability being in this range better than 1%. A.

537.542 : 621.374.32

2969. A FAST MULTIPLE COINCIDENCE CIRCUIT. B.Collinge, A.W. Merrison and D.Eccleshall.
J. sci. Instrum., Vol. 33, No. 2, 72-4 (Feb., 1956).

A multiple coincidence circuit is described which provides for amplitude discrimination of fast photomultiplier pulses. A resolving time of 20 millimicrosec is obtainable. A.

537.542

2970. CLASSROOM DIFFUSION-TYPE CLOUD CHAMBER. A.M.Eich, Jr.
Amer. J. Phys., Vol. 24, No. 3, 176 (March, 1956).

537.542

2971. A SIMPLE FAST-RECYCLING CLOUD CHAMBER. J.Walker, G.Tagliaferri, J.C.Bower and D.W.Hadley.
J. sci. Instrum., Vol. 33, No. 3, 113-15 (March, 1956).

A simple modification to a standard 9 in. diameter expansion chamber is described which decreases the operating cycle from 60 sec to 10 sec. Over-compression is used and the results obtained for different operating conditions throw some light on the mechanism of the process. A.

IONIZATION. THERMIONICS 537.56/58

537.56 : 537.534

2972. THEORY OF THE IONIZATION CASCADE. J.E.Moyal.
Nuclear Physics, Vol. 1, No. 3, 180-95 (1956).

The statistical problem connected with the ionization cascade, that is, the cascade of knock-on electrons produced by a fast primary particle passing through matter, is to obtain the distribution of quantities of interest connected with the cascade, such as the number of electróns in a given energ range, given the ionization cross-sections. An exact solution of this problem is given in very general terms, which will yield all such distributions. With the help of suitable approximations, the distributions of (1) the number of fast knock-on electrons of energy of given value W or greater, and (2) the total number of ion-pairs produced by the primary particle, are obtained in a form suitable for numerical computation. See also Abstr. 3850 (1955). A

537.56 : 539.153.

THE CALCULATION OF AUTO-IONIZATION PROBABILITIES. See Abstr. 2329

537.562

2973. DYNAMICS OF IONIZED MEDIA. S.Gasiorowicz, M.Neuman and R.J.Riddell, Jr.
Phys. Rev., Vol. 101, No. 3, 922-34 (Feb. 1, 1956).

The behaviour of an ionized plasma is discussed in an approximation in which an individual particle is assumed to obey a Fokker–Planck equation, and where its interaction wit the environment is incorporated in the coefficients of the partial differential equation. It is found that if the interaction of the test particle with the medium is divided into a "nearest-neighour" interaction (which manifests itself in "large-angle collisions") and an interaction with the rest of the medium, then the latter can be adequately treated by a perturbation method. If the nearest-neighbour interaction is neglected, th coefficients of successive derivatives form a rapidly decreasi sequence, provided the average kinetic energy greatly exceeds the mean potential energy (which is usually the case). Within the framework of this approximation the coefficients of dampir (dynamical friction) and diffusion in velocity space are calcula ed and the higher (small) coefficients are estimated. A.

537.562 : 538.567

INTERACTION OF ELECTROMAGNETIC WAVES OF RADIO-FREQUENCY IN ISOTHERMAL PLASMAS: COLLISIO CROSS SECTION OF HELIUM ATOMS AND IONS FOR ELECTRONS. See Abstr. 2262

COSMIC RAYS 537.591

537.591.1

2974. INTENSITY AND ANGULAR DISTRIBUTION OF THE PENETRATING COMPONENT OF COSMIC RAYS UNDER GROUND. L.Avan and M.Avan.
C.R. Acad. Sci. (Paris), Vol. 241, No. 9, 1122-4 (Oct. 24, 1955). In French.

Measurement in emulsions of the vertical intensity I under h metres water equivalent of $\Delta = m - n$, where

$$m = \left| \frac{\partial \log I}{\partial \log h} \right|, \quad n = \frac{\partial \log I}{\partial \log \cos \theta},$$

show that for h = −300 metres results are compatible with an exclusive $\pi - \mu$ decay, whereas for −580 metres and more, results can be interpreted as admitting a non-negligible contribution arising from K–μ decay. E.W.Kellermann

537.591.1

2975. OBSERVATIONS OF THE ENERGY-SPECTRUM OF THE COSMIC RADIATION BELOW GROUND. E.P.George and G.S.Shrikantia.

Nuclear Physics, Vol. 1, No. 1, 54-66 (1956).

In nuclear research emulsions exposed at a depth of 57 m.w.e. the momentum of 400 particles was determined by multiple scattering measurements on long tracks. 317 occurred within 30^0 of the vertical, and for this group the momentum spectrum in the range $0 < p < 40$ GeV/c was found to be consistent with a law of the form usually assumed $(N)p \propto (p+p_0)^{-\gamma}$ with $p_0 = 12$ GeV/c and $\gamma = 3$. Particular attention was paid to the momentum interval 0 to 1 GeV/c and no evidence of any anomalies found. The distribution in angle of the tracks was found to be consistent with a law of the form $\cos^n \theta$ with $n = 2.7 \pm 0.2$. For those tracks with grain density at least 1.2 times the plateau value (slow tracks) the exponent was found to be 3.7 ± 0.25. These values correspond to exponents of the cosmic radiation equal to 1.7 ± 0.2 for the fast tracks and 2.7 ± 0.25 for the slow. A.

537.591.1

2976. ČERENKOV COUNTER MEASUREMENT OF MULTIPLY CHARGED COSMIC RAYS. J.Linsley.

Phys. Rev., Vol. 101, No. 2, 826-34 (Jan. 15, 1956).

Measurements have been made on the charge spectrum of cosmic rays at geomagnetic latitude 41^0. The value 88 ± 8 particles/m^2 sec sterad was found for the primary alpha particle flux. For the flux of nuclei with $6 \leq Z \leq 8$ the value 7.4 ± 1.7 particles/m^2 sec sterad was found, and for the $Z \geq 9$ flux, the value 4 ± 2. It is most probable that all of the Li, Be, B nuclei observed were secondary. The experiment sets an upper limit 0.25 on the abundance of primary Li, Be, B relative to the medium elements ($6 \leq Z \leq 10$). The data were obtained during balloon flights at a level of 16 g/cm^2. Events selected by a Geiger counter telescope were measured with a Cherenkov detector, and a record was kept of the pulse heights. When the pulse was greater than two relativistic protons would produce, a cloud chamber above the Cherenkov detector was triggered. In that way 394 events were photographed. As often as not, the photographs showed the track of a multiply charged particle traversing the telescope unaccompanied. The corresponding pulse height then served to determine the particle's charge. A.

537.591.15

2977. ENERGY ESTIMATION OF PHOTON INDUCED CASCADE SHOWERS. P.A.Bender.

Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 980-7 (Nov., 1955).

In order to find the best method by which an experimenter can estimate the energy of a cascade shower seen in a multiplate cloud chamber, a study has been carried out testing various estimation formulae involving different parameters of a shower. Cloud-chamber pictures were scanned for cascade showers resulting from the decay photons of π^0-mesons. The energies of these two photons are related to the angle between them by $\sqrt{E_1 E_2} = mc^2/2 \sin(\theta/2)$. The estimation procedures were tested for consistency with this consequence of the conservation of energy-momentum, the product of the estimated energies being compared with the value calculated from the measured angle between the cores. When the entire shower development takes place in the chamber, the best energy estimate is given by E_0 (MeV) = 33.8P, where P is the total number of track segments in all the compartments times the thickness of a plate in radiation lengths in the direction of the shower. The constant applies to 0.63 cm Pb plates. This expression applies to the range 100-1000 MeV with an estimated standard error of ±20-25%. When only the number, N_{max} of tracks in the compartment in which the shower has its maximum development can be determined, the best estimate is $E_0 = 87.4\ N_{max}$, with an estimated standard error of ±30-35%. Another parameter considered for the case when P can be determined was $\sqrt{PN_{max}}$. $E_0 = 54.5\sqrt{PN_{max}}$ is at least as good an estimate, and perhaps slightly better than, $E_0 = 33.8P$ in the range 200-1000 MeV. The results are compared with shower theory and with R.R.Wilson's "Monte Carlo" results. Excellent agreement is found with the latter, using a cutoff of 8 MeV, as regards fluctuations as well as average behaviour. It follows that the uncertainties in energy estimation by the above formulae are due mainly to physical fluctuations in the shower development. A.

537.591.15

2978. A SEARCH FOR SECONDARY MAXIMA IN COSMIC RAY TRANSITION CURVES. I. C.B.A.McCusker and B.G.Wilson.

Proc. Phys. Soc. A, Vol. 68, Pt 11, 1086-7 (Nov., 1955).

In the course of a G.M. counter investigation of the nucleon cascade in lead, an experiment similar to that of Bothe (Abstr. 8398/1954) was performed, without however finding any evidence for secondary maxima for total lead thickness up to 98 cm. A small maximum at 16 cm for two-fold coincidences, while being present for the two lower counter trays, is absent for the upper. It is therefore attributed to μ-meson decays in the floor, in agreement with Harding (Abstr. 5495, 6270/1955). R.H.W.Johnston

537.591.15

2979. A SEARCH FOR SECONDARY MAXIMA IN COSMIC RAY TRANSITION CURVES. II. P.D.McCormack, C.B.A.McCusker and B.G.Wilson.

Proc. Phys. Soc. A, Vol. 68, Pt 11, 1088-9 (Nov., 1955).

Explanations of the above effect in terms of narrow-angle showers or neutral particle decays were investigated using a penetrating shower (p.s.) set in conjunction with a cloud chamber. No increase of narrow angle ($<5^0$) events was observed for 15 cm lead above the apparatus. Such events constituted only 6% of the total number of p.s., and 0.1% of the single meson traversals. A search for decay events (using a modified selection system) was also negative.

R.H.W.Johnston

537.591.15

2980. INFLUENCE OF THE EARTH'S MAGNETIC FIELD ON AIR SHOWERS. R.J.Norman.

Phys. Rev., Vol. 101, No. 4, 1405-6 (Feb. 15, 1956).

Cocconi has estimated that the deflection of air shower particles in the earth's magnetic field should produce some ellipticity of shower structure, with the major axis in the E-W direction. Experimental evidence is advanced to show that the variation in shower structure at sea level is less than 4%, which compares favourably with Cocconi's theoretical value of about 2% and proves that, at low altitudes, the displacement of particles from the shower axis produced by the earth's magnetic field is negligible in comparison with Coulomb scattering. A.

537.591.3

2981. ABSORPTION OF THE CREATED NEUTRON COMPONENT OF THE COSMIC RADIATION IN LEAD AND ALUMINIUM. H.Reich.

Z.Naturforsch., Vol. 10a, No. 12, 914-19 (1955). In German.

Using 'differential' methods the absorption of the neutron component has been measured in lead and aluminium; that for lead shows a smooth variation up to 28 cm, giving an attenuation length of 28 cm (about 320 g/cm^2). A slight indication was found of a maximum at 21 cm but it was barely significant above the experimental errors. With aluminium a maximum at 8 cm was found. The results are discussed in terms of current ideas. D.J.Prowse

537.591.5

2982. DAILY TOTAL COSMIC RAY INDICES AT HUANCAYO AND WORLD GEOMAGNETIC INDICES AND MAGNETIC STORMS. S.L.Malurkar.

Acta phys. Hungar., Vol. 5, No. 2, 241-58 (1955).

The relationship between the time variations of the earth's magnetic field and the corresponding variations in cosmic-ray ionization has been looked into by Messerschmidt, by Forbush, by Hess, by Hogg and by Lange and Forbush among others. Striking effects during magnetic storms have been reported but quite a few occasions exist when no such effect could be detected. A method of characterizing the cosmic-ray values recorded in a day in analogy with magnetic variations at an observatory is given. The cosmic-ray indices have been calculated from Lange and Forbush's two hourly mean readings at Huancayo for all days in 1940 and for magnetically disturbed days from June 1936 to December, 1944. The values have been shown against total geomagnetic indices of the world and dot diagrams also plotted. In the daily cosmic-ray indices for 1940, the dot diagram does not point definitely to any relation, i.e. the scatter is too broad. In the dot diagram for the disturbed days there is a sort of general increase of world geomagnetic indices and cosmic-ray indices. But the increase seems to fall into two branches, one where the cosmic-ray index is large and the magnetic index is relatively small and the other where the cosmic-ray index is comparatively smaller but the magnetic one seems to dominate. More definite conclusions may be possible if data from other observatories are also analysed. A.

537.591.5

2983. SEARCH FOR A SIDEREAL VARIATION OF THE COSMIC RAY INTENSITY AT HIGH ENERGIES. J.K.Crawshaw and H.Elliot.
Proc. Phys. Soc. A, Vol. 69, Pt 2, 102-9 (Feb., 1956).

Extensive air showers with energies of about 10^{16} eV and 10^{17} eV were recorded at geographic latitude 53° N by means of counter sets separated by about 150 m and 300 m. Harmonic analysis of the shower frequencies has revealed no evidence for a sidereal daily variation with amplitude exceeding the statistical uncertainties, which are 2.5% and 6% respectively. No evidence has been found for a solar daily variation with amplitude exceeding 2.5% for 10^{16} eV showers. A solar daily variation has been found for 10^{17}eV showers with an amplitude of 19% and a time of maximum at about 1300 hr. The interpretation of this result is briefly discussed. A.

537.591.5

2984. SCINTILLATION SPECTROMETER STUDY OF COSMIC RADIATION AT GREAT DEPTHS. S.Standil and R.W.Pringle.
Phys. Rev., Vol. 101, No. 4, 1395-6 (Feb. 15, 1956).

A scintillation spectrometer has been used to observe cosmic-ray events at depths down to 10 000 feet in an oil well. The observed intensity-depth relationship can be explained in terms of the μ-meson component and associated showers. The shower to μ-meson ratio increases by a factor of 4 in going from sea level to a depth of 1000 metres water equivalent. A.

537.591.5

2985. SOLAR ORIGIN OF COSMIC-RAY TIME VARIATIONS. P.Morrison.
Phys. Rev., Vol. 101, No. 4, 1397-404 (Feb. 15, 1956).

The sun is known to be responsible during at least some solar flares for sharp increases in the cosmic-ray intensity on earth. In contrast to the flare pulses, the other principal changes in cosmic-ray intensity are all smaller in amplitude, less steep in energy dependence (extending perhaps to 30 BeV/c), much slower in time scale, and very much more isotropic (worldwide). These latter changes are not correlated sharply with any conspicuous solar event. A common cause for all of the nonflare cosmic-ray changes is here proposed: time (and energy) modulation of the incoming cosmic-ray beam by the random diffusion of the particles through turbulent clouds of magnetized plasma emitted from the sun. The sporadic cosmic-ray storm decreases (Forbush events) occur when the earth is immersed in a strong fresh cloud following a solar flare. The eleven-year variations in intensity and low-energy spectrum arise from the combined effect of much weaker and more diffuse clouds which travel across the solar system to the region of the outer planets. The recurrent 27 day effects depend on the presence near the earth of a region of longer diffusion mean free path, which punches a channel into the pre-existing clouds. The origin of the clouds in active centres and the channels in magnetic monopole regions of the sun is discussed and parameters obtained which describe the clouds, and their motions, adequate to produce the observed effects and quantitatively, astrophysically plausible. The small but complex diurnal cosmic-ray variations are not discussed in detail, but appear to fit in naturally. The observed variation of all these effects throughout one solar cycle agrees with the picture presented. A

537.591.5 : 523.74

2986. THE 27-DAY RECURRENCE TENDENCY OF COSMIC RAY INTENSITY. I.J.van Heerden and T.Thambyahpillai
Phil. Mag., Vol. 46, 1238-51 (Nov., 1955).

The 27-day recurrence tendency of the cosmic-ray intensity has been studied for the nucleon, meson and electron components of the cosmic radiation and the amplitude of the variation is found to be greater for the nucleon component, furthermore the changes in cosmic-ray intensity seem to precede those of magnetic activity by 4 or 5 days. The 27-day period corresponds to the time of rotation of the sun and this would seem to indicate that the cosmic-ray intensity changes are associated with solar disturbances which, after a delay of several days, produce magnetic storms. There is some evidence to show that the recurrence tendency is due to decreases in intensity which occur at 27-day intervals. A.

537.591.5 : 550.385

2987. ON THE CORRELATION BETWEEN THE INTENSITY OF DIFFERENT COMPONENTS OF COSMIC RAYS, THE METEOROLOGICAL CONDITIONS AND MAGNETIC STORMS. B.Trumpy.
Univ. Bergen Årbok (1954; publ. 1955) No. 2, 19 pp.

From continuous recordings of the total cosmic radiation, the "hard" component (15 cm Pb) and the soft component during 1953 and up to May 1954, the barometric coefficient a, the height coefficient b, and the temperature coefficient c were obtained. From the measurement of a for the soft component it is concluded that this component at sea level is produced not entirely by the meson component. Results for c for the soft component are as yet not statistically significant. Changes of the cosmic-ray intensity connected with 14 cases of world-wide magnetic storms have been examined during 1952, 1953, 1954. An exact and detailed correlation does not seem to exist. It appears that the variation of the soft component during a magnetic storm is greater than the corresponding variation of the hard component and that there exists a diurnal variation of the cosmic-ray decreases during magnetic storms. E.W.Kellermann

537.591.8

2988. THE FORMATION OF ^{32}P FROM ATMOSPHERIC ARGON BY COSMIC RAYS. L.Marquez and N.L.Costa.
Nuovo Cimento (Ser. 10) Vol. 2, No. 5, 1038-41 (Nov., 1955).

It is shown by experiments that radioactive P^{32} is formed as a spallation product of argon by cosmic rays. This P^{32} is found in rain water, and its average activity in fresh Rio de Janeiro water is 0.20 d.p.m./litre. A.

537.591.8

2989. COSMIC-RAY TRIDENTS. M.Avan and L.Avan.
C.R. Acad. Sci. (Paris), Vol. 241, No. 19, 1284-6 (Nov. 7, 1955). In French.

Their cross-section for production on arms of pairs has been determined as function of primary energy E. For values of E between 0.8 and 10 BeV, $\sigma = (2.2 \pm 0.6)\ 10^{-28}$ cm^2, $\bar{E} \cong 3.5$ BeV; for E between 0.1 and 0.8 BeV, $\sigma = (0.34 \pm 0.13)\ 10^{-28}$ cm^2, $\bar{E} \cong 0.25$ BeV. E.W.Kellerman

537.591.8

2990. THE INTERACTIONS OF COSMIC RAY ALPHA-PARTICLES. C.J.Waddington.
Phil. Mag. (Ser. 8), Vol. 1, 105-8 (Jan., 1956).

Interactions of alpha-particle primaries (energy >0.5 BeV/nucleon, median energy 1.3 BeV/nucleon) were studied using emulsion exposed at balloon altitudes. An interaction length 20.5 ± 2.2 cm was obtained by searching along identified alpha-tracks. No significant energy-dependence was observed. Star-prong distributions (N_s and N_h) were obtained which differ from those of Ceccarelli et al. (Abstr. 5504/1955), the authors method being free from observational bias. It is suggested that the experimental features may be explained by assuming a "black" nucleus with transparent boundary layer, rather than a simple "black" nucleus as proposed by Ceccarelli et al.
R.H.W.Johnston

MAGNETISM 538

538.082 : 621.317.44

2991. A NEW MAGNETIC FLUX PROBE. J.E.Parton and G.D.Stairmand.
J. sci. Instrum., Vol. 32, No. 12, 464-7 (Dec., 1955).

A differential-capacitor probe designed primarily for investigating magnetic fields in the confined spaces of rotating machines is described; it is suitable for use in fields from 10 mWb/m^2 (100 G) upwards and will detect both steady and transient fields. In the measuring head of the probe are three parallel members; the applied field causes a deflection of the earthed, current-carrying middle member. This movement changes the capacitances to earth of the two outer members which form two arms of an a.c. bridge. The out-of-balance voltage caused by these changes in capacitance is, after suitable amplification, indicated on a meter. Experimental characteristics are given for steady and for varying fields. The characteristics of the probe are discussed. A.

538.082 : 621.317.44

2992. SOME ASPECTS IN THE DESIGN OF A TORQUE MAGNETOMETER. F.W.Harrison.
J. sci. Instrum., Vol. 33, No. 1, 5-6 (Jan., 1956).

The magneto-torsional system of a torque magnetometer is shown to be unstable if the torsion constant of the suspending wire is not chosen correctly. The way in which this fact limits the sensitivity of the apparatus is indicated. A.

538.11 : 536.75

2993. MAGNETIC RESONANCE AND THE PRINCIPLE OF MINIMUM ENTROPY PRODUCTION. R.K.Wangsness.
Phys. Rev., Vol. 101, No. 1, 1-4 (Jan. 1, 1956).

It is shown by statistical mechanical methods that in the steady state attained by a system of magnetic moments in a resonance experiment the rate of entropy production is a minimum. It is assumed that the external field has a circularly polarized component perpendicular to a constant component, and that the contact between the spin system and the heat bath is provided only by strong collisions. Because of the coherent relations among the phases of the probability amplitudes, the average off-diagonal elements of the density matrix do not vanish in this case, and it is shown to be necessary to extend the usual statistical mechanical definition of entropy to include terms involving these elements. A.

538.114

2994. STATISTICS OF THE THREE-DIMENSIONAL FERROMAGNET. IV. THE FACE CENTRED AND BODY CENTRED CUBIC LATTICES. E.Dempsey and D.ter Haar.
Physica, Vol. 22, No. 1, 1-13 (Jan., 1956).

For Pt III, see Abstr. 587 (1954). Kramers' variational method is used to derive the partition functions per spin for the cubic ferromagnetic structures. These partition functions are compared with the partition functions derived by the approximate methods of Bethe, Kirkwood and Zernike. The case of the two dimensional square ferromagnet with both nearest and next nearest neighbour interactions is also briefly discussed.
A.

538.114

2995. APPLICATION OF THE BETHE-WEISS METHOD TO FERRIMAGNETISM. J.S.Smart.
Phys. Rev., Vol. 101, No. 2, 585-91 (Jan. 15, 1956).

The Bethe–Weiss theory of ferromagnetism is extended and applied to systems containing two nonequivalent sets of sites, designated by A and B, for the magnetic atoms. Each B atom has n_a nearest A neighbours and each A atom has n_b nearest B neighbours. In the theoretical development, the following restrictions are imposed: the spin per atom is ½ and only nearest neighbour A - B interactions are considered ($\alpha = \beta = 0$, in Néel's notation). The A - B interaction J may be either positive or negative, however, so that the sublattice magnetizations below the Curie temperature may be either parallel or antiparallel, respectively. Experessions are derived for the Curie temperature and for the susceptibility above the Curie temperature. If the two sublattices are made equivalent, results for positive J reduce to Weiss' equations for the ferromagnetic case and results for negative J reduce to Li's equations for the antiferromagnetic case. A table of values of the ratio $kT_C/|J|$ as computed by the Néel, Ising–Bethe and Bethe–Weiss theories is given for various values of n_a and n_b. For a given magnitude of J, the Bethe–Weiss Curie temperature for negative J is always greater than that for positive J. An empirical formula which approximates the Bethe–Weiss criterion for the existence of a ferrimagnetic transition is $n_a n_b > 5(n_a + n_b)/2$. The Néel and Bethe–Weiss susceptibilities are calculated and compared for a ferrimagnet with $n_a = 4$, $n_b = 8$. The two general expressions for the susceptibility are found to agree quantitatively at extremely high temperatures. It is shown that for a ferrimagnet with J less than 0 the sublattice magnetizations in an external field become antiparallel not at the Curie temperature but considerably above.
A.

538.114

2996. POSSIBLE SOURCE OF LINE WIDTH IN FERROMAGNETIC RESONANCE. A.M.Clogston, H.Suhl, L.R.Walker and P.W.Anderson.
Phys. Rev., Vol. 101, No. 2, 903-5 (Jan. 15, 1956).

Discusses the effect of sample finiteness and lattice imperfections on spin-wave dispersion and hence line width.
E.P.Wohlfarth

538.114 : 548.0

2997. DOMAIN WALLS IN ANTIFERROMAGNETS AND THE WEAK FERROMAGNETISM OF α-Fe_2O_3. Y.Y.Li.
Phys. Rev., Vol. 101, No. 5, 1450-4 (March 1, 1956).

At the Néel temperature local nucleations of the antiferromagnetic order and their subsequent growth lead to the formation of domain walls. The domains in an antiferromagnet are thermodynamically stable only when the anisotropy force opposing the gradual switch of spins in the Bloch zone is small such that the wall energy is offset by the gain in entropy. However, in most cases the domain wall would owe its stability to the presence of lattice imperfections, such as interstitial atoms or dislocations. A typical magnetization curve of an antiferromagnet with ferromagnetic domain walls is depicted. The weak ferromagnetism observed in the (111) plane of α-Fe_2O_3 (hematite) is identified with the magnetization in domain walls pinned down by lattice imperfections. An assumption that the linear dimension of domains is, on the average, 10^4 atomic spaces gives the observed strength of the weak ferromagnetism. The disappearance of this ferromagnetism at about -20°C when the magnetic axis switches from a $[11\bar{2}]$ direction to the [111] direction is due to the extreme difference

in the anisotropy force in the (111) plane and that in a plane containing the [111] axis. The following experimental findings on α-Fe_2O_3 are interpreted: (a) The variation of the ferromagnetism as the temperature increases shows the general feature of the decrease of long-range order in cooperative phenomena, being very gradual at lower temperatures and growing sharper and sharper as the temperature approaches the Néel point. (b) In the transition region of the two antiferromagnetic states of α-Fe_2O_3 an applied field in the (111) plane causes a decrease of the temperature at which the ferromagnetic effect and the large magnetostriction effect disappear but produces no change in the neutron diffraction intensity of the (111) line. A.

538.12

2998. RELATION BETWEEN AN ARBITRARY FIELD $\vec{B}(r, \varphi, z)$ AND THE ROTATIONALLY SYMMETRIC FIELD $\vec{B}^R(r, z)$ HAVING $B_Z^R(o, z) = B_Z(o, z)$. APPLICATIONS. P.Gautier.
C.R. Acad. Sci. (Paris), Vol. 241, No. 15, 930-2 (Oct. 10, 1955). In French.

An arbitrary magnetic field is shown to bear a certain relation to a rotationally symmetrical field with which it coincides in magnitude and direction along a particular axis. It is deduced that the flux of the arbitrary field through a search coil is formally the same as if the field had been rotationally symmetrical about the axis of the coil.
A.E.I. Research Laboratory

538.22 : 538.63

2999. SYMMETRY OF GALVANOMAGNETIC EFFECTS IN ANTIMONY. H.J.Juretschke.
Acta cryst., Vol. 8, Pt 11, 716-22 (Nov., 1955).

The phenomenological theory of galvanomagnetic effects in a medium of point-group symmetry 3m, isomorphic to antimony, has been developed for the case that these effects can be described in terms of an expansion in powers of the magnetic field. Schemes of coefficients of these powers up to and including the fourth power are constructed explicitly. Various experimental arrangements for a determination of all independent constants are discussed, and the voltages to be expected in each case are worked out in detail. A final section lists the relations between the galvanomagnetic coefficients of the conductivity and resistivity tensors. A.

538.221/.222

3000. ON THE SUSCEPTIBILITY OF $CuCl_2.2H_2O$ POWDER IN THE ANTIFERROMAGNETIC AND PARAMAGNETIC STATES. L.C.van der Marel, H. van den Broek, J.D.Wasscher and C.J.Gorter.
Physica, Vol. 21, No. 9, 685-94 (Sept., 1955).

The magnetic susceptibility of $CuCl_2.2H_2O$ powder has been measured in the temperature regions of liquid hydrogen and helium. It is found to deviate appreciably from the predictions of molecular field theory: its value at T_N is about 30% too low and it has not a sharp peak at the Néel temperature. Comparison with simultaneous specific heat measurements gives indications of a short-range ordering persisting above the Néel temperature. The field dependence of the powder susceptibility is in qualitative agreement with expectations on the basis of Nagamya and Yosida's formula. Preliminary measurements on the susceptibility of a single crystal are in reasonable agreement with the values calculated from the powder measurements. A.

538.221/.222

3001. MAGNETIC PROPERTIES OF SOME ANHYDROUS CHLORIDES OF THE IRON GROUP. I. MAGNETIC RESONANCE. J.W.Leech and A.J.Manuel.
Proc. Phys. Soc. B, Vol. 69, Pt 2, 210-19 (Feb., 1956).

Measurements of paramagnetic resonance absorption in $CrCl_3$ and $NiCl_2$ in the temperature range 13.15°K to 293°K are reported. The height of the absorption curve decreases and the line width increases as the temperature is lowered through the region of the cryomagnetic anomalies in these salts. The results are discussed in Pt II (see abstract following), where consideration of other experimental work suggests that the magnetic transition in these salts at low temperatures is essentially ferromagnetic rather than antiferromagnetic. $FeCl_2$ and $CoCl_2$ were also examined in the same temperature range but paramagnetic resonance was not observed. A.

538.221/.222

3002. MAGNETIC PROPERTIES OF SOME ANHYDROUS CHLORIDES OF THE IRON GROUP. II. INTERPRETATION OF THE CRYOMAGNETIC ANOMALIES IN $CoCl_2$, $FeCl_2$, $NiCl_2$ AND $CrCl_3$. J.W.Leech and A.J.Manuel.
Proc. Phys. Soc. B, Vol. 69, Pt 2, 220-30 (Feb., 1956).

It is shown that experimental evidence of magnetic properties and crystalline structure of $CoCl_2$, $FeCl_2$, $NiCl_2$ and $CrCl_3$ conflict with the assumption that these salts are antiferromagnetic. A two-dimensional ferromagnetic structure is indicated and the observed magnetization curves can be explained as due to the influence of high shape anisotropy associated with single layer domains.

538.221

3003. AGAIN ON THE WORK ON PURE IRON. L.Špaček.
Czech. J. Phys., Vol. 5, No. 3, 431-3 (Aug., 1955). In German.

REPLY TO THE COMMENT OF L.ŠPAČEK. J.Bednář, J.Brož, K.Šmirous, Z.Tronsil.
Ibid, Vol. 5, No. 3, 433-4 (Aug., 1955). In German.
See Abstr. 4782 (1955).

538.221

3004. MAGNETIC DOMAIN STRUCTURE IN TWINNED CRYSTALS OF SILICON IRON. R.Street and E.O.Hall.
Proc. Phys. Soc. B, Vol. 68, Pt 12, 1033-7 (Dec., 1955).

The modification of magnetic domain structures on {110} surfaces of single crystals of silicon iron by the presence of twin bands is examined by colloid deposition techniques. It appears that the structure is determined by the presence of free poles alternately of opposite sign on the interface between the twin and the crystal, giving rise to regular domains separated by 180° boundary walls. A.

538.221

3005. SOME PROPERTIES OF FERRITES IN CONNECTION WITH THEIR CHEMISTRY. E.W.Gorter.
Proc. Inst. Radio Engrs, Vol. 43, No. 12, 1945-73 (Dec., 1955).

After an elementary introduction, it is shown how the molecular-field hypothesis can account for the magnetic properties of ferromagnetics and antiferromagnetics, and for the noncompensated antiferromagnetics, with which latter materials the paper is concerned. A brief description of the spinel lattice is given, and an account of the crystal chemistry of the spinels which is necessary to understand the experimental saturation magnetizations which are discussed. A short survey of methods of preparation is given. The second part discusses the anisotropies, and some of the magnetization processes which influence permeability, and the factors which influence high-frequency permeability and losses. Among these are the ferromagnetic resonance phenomenon and the dimensional resonance and relaxation phenomena. In this part the way in which these factors are influenced by chemical composition and preparation technique is indicated. Finally, a short history of the development of the ferrites is given. 63 refs. A

538.221

3006. INITIAL PERMEABILITIES OF SINTERED FERRITES. G.W.Rathenau and J.F.Fast.
Physica, Vol. 21, No. 12, 964-70 (Dec., 1955).

A magnetization process which may contribute to the initial permeability μ_0 of sintered NiZn ferrites is ascribed to

he displacement of mobile walls. Wall displacements are also esponsible for the dependence of μ_0 on the angle between the irections of magnetization and of a.c. field demagnetization. The reversible influence of stress on μ_0 can be accounted for y considering only simultaneous spin rotations. The influence f an anisotropic spin distribution on μ_0 in the absence of xternal stress is a strong argument for the assumption that otation is the preponderant initial magnetization process for hese porous ferrites. A.

538.221

3007. THE DOMAIN STRUCTURE OF THIN IRON FILMS. B.Elschner and D.Unangst.
Z. Naturforsch., Vol. 11a, No. 1, 98 (1956). In German.

Powder patterns on evaporated films of thickness above 350 A show dagger-like domains, separated by 90° walls, at ilm edges and imperfections. The effect of an applied magnetc field was also investigated. E.P.Wohlfarth

538.221 : 538.632

3008. THE SPONTANEOUS HALL EFFECT IN FERROMAGNETICS. I. J.Smit.
Physica, Vol. 21, No. 11, 877-87 (Nov., 1955).

Apart from the normal Hall voltage a magnetized ferromagnetic material usually shows a relatively large extra voltage in the same direction, which can be found by linear extrapolation to B = 0. It is shown that this spontaneous Hall effect cannot exist in a perfectly periodic lattice. Measurements at different temperatures suggest that the effect is closely related with the electrical resistivity ρ of the material. Existing theories on the origin of the effect are shown to be invalid, and it is shown that the explanation has to be based on the anisotropic scattering, caused by spin-orbit interaction, of the conducting electrons against the imperfections of the lattice. A.

538.221 : 538.632

3009. HALL EFFECT AND MAGNETIC PROPERTIES OF ARMCO IRON. S.Foner.
Phys. Rev., Vol. 101, No. 6, 1648-52 (March 15, 1956).

The Hall effect is examined in detail over a large range of fields. The effect is given by a sum of the ordinary and the extraordinary effect over the range investigated, including the nonlinear region. It is shown that the extraordinary Hall constant is independent of field within the experimental error. The approach to magnetic saturation in Armco iron is examined at high fields. The Hall effect is shown to be useful for studying detailed behaviour of magnetic properties. A.

538.221 : 539.132

3010. NUCLEAR RELAXATION IN AN ANTIFERROMAGNETIC SINGLE CRYSTAL. G.E.G.Hardeman, N.J.Poulis and W.van der Lugt.
Physica, Vol. 22, No. 1, 48-56 (Jan., 1956).

The proton spin relaxation time in the antiferromagnetic single crystal of $CuCl_2.2H_2O$ was measured in the temperature region of liquid helium. A strong temperature dependence was found, the relaxation time increasing to a few seconds at 1.2°K. Up to 2.5°K the results can be described in terms of a single model concerning the fluctuating magnetic moments of the Cu ions. A.

538.221 : 548.74

MAGNETIC PROPERTIES OF A SERIES OF PEROVSKITE-TYPE COMPOUNDS. See Abstr. 2563

538.221 : 621.318.1

3011. FERROMAGNETISM IN RELATION TO ENGINEERING MAGNETIC MATERIALS. F.Brailsford.
Proc. Instn Elect. Engrs, Paper No. 1947, publ. Feb., 1956 (Vol. 103 A, 39-51).

After a brief introductory account of the earlier development of the subject of ferromagnetism a review is given of theoretical and experimental work mainly within the past ten years. This includes an account of ferromagnetic domains and of the small-particle theory of high coercivity. A description of the ferrites and of ferrimagnetism is given, and this is followed by a discussion of recent observations and ideas on the magnetic phenomena occurring at frequencies up into the microwave region. A.

538.221 : 621.318.2

3012. TECHNICAL PROPERTIES OF IRON POWDER MAGNETS. E.H.Carman.
Brit. J. appl. Phys., Vol. 6, No. 12, 426-9 (Dec., 1955).

Coercive force, remanence and maximum-energy product of compacts of iron are measured as functions of density of packing (d/d_0) and X-ray particle size (L). The iron is prepared by hydrogen reduction of ferric oxide and for the grade used optimum technical properties are: B_r = 5200 gauss, $(B.H)_{max}$ = 0.82 x 10^6 gauss: oersted, and $_BH_c$ = 400 oersted when L = 300 A and d/d_0 = 0.5. Maximum coercive force obtained is 610 oersted when d/d_0 = 0.3 . For d/d_0 fixed the three magnetic quantities increase with decreasing particle size, the increase being greatest with B_r and $(B.H)_{max}$. The increase in remanence is discussed in terms of its ratio to saturation magnetization and it is suggested that the observed increase is related to packing effects. Measurement of the influence of oxygen impurity indicates that the presence of a few % of oxide does not appreciably affect the quality of the magnets. A.

538.221

3013. PARAMAGNETISM OF SOME RARE EARTH FERRITES. J.C.Barbier and R.Aléonard.
C.R. Acad. Sci. (Paris), Vol. 242, No. 1, 83-5 (Jan. 4, 1956). In French.

Reports results of susceptibility measurements between 950° and 1450°K on the ferrites $Fe_2O_3.M_2O_3$ where M = La, Sm, Pr, Nd, Gd. The inverse susceptibility, temperature curves may be approximated by hyperbolae with slight curvature; the Curie constants deduced from the slopes of the asymptotes are larger than those calculated from the ionic moments except for the Gd ferrite. E.P.Wohlfarth

538.222

3014. FINE STRUCTURE OF THE PARAMAGNETIC RESONANCE SPECTRUM OF THE Cr^{+++} ION IN CHROMIUM CORUNDUM. A.A.Manenkov and A.M. Prokhorov.
Zh. éksper. teor. Fiz., Vol. 28, No. 6, 762 (1955). In Russian.

An investigation was made of the paramagnetic resonance in chromium corundum (the solid solution Al_2O_3 - Cr_2O_3), with a chromium concentration of 0.05%, at room temperature, using two frequencies of the order of 10^4 Mc/s. The initial splitting of the spin levels in the absence of the magnetic field was 0.3824 cm^{-1}, more than twice the value for alum, and the g-factors were $g_{\parallel} = 1.9894 \pm 0.0006$, $g_{\perp} = 1.9867 \pm 0.0006$. J.B.Sykes

538.222

3015. PARAMAGNETIC SUSCEPTIBILITY MEASUREMENTS ON PdAg ALLOYS. E.Kronqvist.
Ark. Fys., Vol. 10, Paper 5, 49-57 (1955).

The paramagnetic suceptibility of Pd and some Pd-rich PdAg alloys has been determined from room temperature up to about 1000°K. The experimental results have been compared with the collective electron theory for magnetism, developed principally by Stoner. Good agreement with this theory has been obtained in the interval of temperature studied. Further, it has been shown that cold-working does not appreciably change the paramagnetism of Pd and Pd-rich PdAg alloys. A.

538.222

3016. DETERMINATION AND PROPERTIES OF ANISOTROPY IN PARAMAGNETIC RESONANCE ABSORPTION.
M.B.Palma Vittorelli, M.U.Palma, D.Palumbo and M.Santangelo.

Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 811-19 (Oct., 1955).

In order to measure the anisotropy in paramagnetic resonance absorption in single crystals, a method has been devised which does not require initial knowledge of the directions of the principal magnetic axes, and by which it is possible to determine the principal values together with the directions of the axes. It is shown that under certain assumptions the characteristic surface of g is an ellipsoid, and that thus, with a proper choice of the axes, the following equation holds: $g = g_x\alpha^2 + g_y\beta^2 + g_z\gamma^2$, where α, β, γ stand for the direction cosines of H. The method has been applied for completing previous measurements, thus rendering their interpretation possible. A.

538.222

3017. MAGNETIC RESEARCHES ON ADIABATICALLY DEMAGNETIZED CHROMIUM METHYLAMINE ALUM. J.A.Beun, M.J.Steenland, D.De Klerk and C.J.Gorter. Physica, Vol. 21, No. 10, 767-82 (Oct., 1955).

The magnetic susceptibility of $CrCH_3NH_3(SO_4)_2.12H_2O$ has been studied first in zero external field. The influence of the amplitude and the frequency of the measuring field on the value of the susceptibility was measured. Also the hysteresis effects were investigated. Special attention was paid to the behaviour of the susceptibility in external fields, both transverse and longitudinal, below its maximum as a function of entropy. Two marked bends have been found in the magnetization curves. In transverse fields striking anisotropies with a binary symmetry showed up. A discussion is given of the measured curves, especially for the lowest temperatures, based on the occurrence of antiferromagnetic domains. A.

538.222

3018. THE MAGNETIC SUSCEPTIBILITY OF METALLIC CERIUM. L.F.Bates, S.J.Leach and R.G.Loasby. Proc. Phys. Soc. B, Vol. 68, Pt 11, 859-61 (Nov., 1955).

The magnetic susceptibility of pure metallic cerium has been measured over the temperature range 90° to 1057°K. At 293°K the susceptibility is 17.5 ± 0.2 e.m.u. per g, and between 90° and 295°K the relation $\chi = 0.00588/(T + 42)$ is followed. The observed temperature variation of susceptibility can be explained on the basis of a change in thermal population of $^2F_{5/2}$ and $^2F_{7/2}$ levels separated by 1340 cm^{-1}, upon which is superimposed a small temperature-independent paramagnetism. A.

538.222

3019. MAGNETIC PROPERTIES OF NICKEL TELLURIDE. E.Uchida and H.Kondoh. J. Phys. Soc. Japan, Vol. 11, No. 1, 21-7 (Jan., 1956).

An experimental study of the magnetic properties of $NiTe_x$, where x is the molal content of tellurium. When x is between 0.1 and 0.65, this substance is found to be ferromagnetic; the variations with composition of the saturation magnetization and of the Curie temperature show evidences of a transition at x = 0.33 (27 atomic per cent Te) from a heterogeneous phase beginning at pure metallic nickel to a certain ferromagnetic homogeneous phase. A paramagnetic phase appears above x = 0.7 (41 atomic per cent Te), although its paramagnetic behaviour is not truly paramagnetic in the Curie–Weiss sense, especially at high temperatures; a considerable temperature-dependence of the susceptibility is observed at low temperatures and a temperature-independent susceptibility of a small value less than 0.05 e.m.u./g at high temperatures. This behaviour of the susceptibility is apparently similar to that of Cu-rich Cu-Ni alloys studied by Kaufmann and Starr, though a marked dissimilarity is also found between their characters, an antiferromagnetic character being present in $NiTe_x$ at paramagnetic compositions. A.

538.222

3020. NUCLEAR MAGNETIC RELAXATION OF NONUNIFORM SYSTEMS. S.Broersma. J. chem. Phys., Vol. 24, No. 1, 153-60 (Jan., 1956).

The relationship between the relaxation time measured for a heterogeneous system and the relaxation times and concentrations of the components is discussed. In general, the value of the "average" relaxation time observed is dependent upon the method of measurement. When the relaxation effects are completely averaged out within the time of measurement, the system behaves as a single phase while the relaxation time is determined by the time average (or mass average) of 1/T. If no averaging takes place at all the signal strength is determined by the sum of the magnetizations of the components, each with its own relaxation time: In the transition case one should use the concept "amount of relaxation during time t", $\int_0^t dt'/T$. Two examples of this transition have been examined experimentally. They are determined by the phenomena of diffusion and adsorption, both of which are able to delay the completion of the "relaxation life cycle". The protons in hydrocarbons mixed with paramagnetic salt crystals, exhibit the properties of a two phase system; also dilute solutions of paramagnetic ions in water. In principle it is possible to obtain information about self diffusion in liquids, hydration of ions, dispersivity of solid paramagnetic material. Instrumental techniques used in the detection of the signal are described. A.

538.222

3021. ELECTRON SPIN PARAMAGNETISM OF LITHIUM AND SODIUM. R.T.Schumacher and C.P.Slichter. Phys. Rev., Vol. 101, No. 1, 58-65 (Jan. 1, 1956).

The paramagnetic susceptibility χ_p^e of conduction electron spins is isolated experimentally from the total magnetic susceptibility in metallic lithium and sodium by studying the intensity of the conduction-electron spin resonances. The absolute intensity of absorption is calibrated by comparison with the nuclear resonance of the metal nuclei in the same sample and at the same frequency, the two resonances being observed merely by changing the static magnetic field. In this manner χ_p^e is measured in terms of the nuclear static susceptibility, χ_p^n, which in turn can be calculated accurately from the Langevin-Debye formula. A narrow band modulation technique gives improved signal to noise over earlier work. The values of χ_p^e are (2.08 ± 0.1) x 10^{-6} c.g.s. volume units for lithium at 300°K and (0.95 ± 0.1) x 10^{-6} c.g.s. volume units for sodium at 79°K, rather good agreement with the theory of Pines and Bohm, but in substantial disagreement with the simple Pauli model, or the results of Sampson and Seitz. Experimental precision does not permit conclusions to be drawn about the diamagnetism of conduction electrons. A.

538.222

3022. ANISOTROPY IN THE PARAMAGNETIC ELECTRON RESONANCE SPECTRA OF IRRADIATED GLYCINE. J.Uebersfeld and E.Erb. C.R. Acad. Sci. (Paris), Vol. 242, No. 4, 478-80 (Jan. 23, 1956). In French.

538.222

3023. PARAMAGNETIC RESONANCE ABSORPTION IN COPPER FORMATE. J.Shimada, H.Abe and K.Ôno. J. Phys. Soc. Japan, Vol. 11, No. 2, 137-9 (Feb., 1956).

Paramagnetic resonance in single crystals of copper formate tetrahydrate and its dihydrate was investigated at room temperature with microwaves in the 5 to 11 mm range. Either crystal has only one absorption peak at any direction of static magnetic field. The line width of the tetrahydrate is about 400 Oe and that of dihydrate about 200 Oe. The shape of these lines is Lorentzian. A.

538.222

3024. ELECTRON SPIN RESONANCE OF 1, 4-NAPHTHOSEMIQUINONE ION. J.E.Wertz and J.L.Vivo. J. chem. Phys., Vol. 24, No. 2, 479 (Feb., 1956).

538.222 : 535.343

3025. THE MAGNETIC AND SPECTROSCOPIC PROPERTIES OF CERTAIN RARE-EARTH DOUBLE NITRATES. B.R.Judd.
Proc. Roy. Soc. A, Vol. 232, 458-74 (Nov. 22, 1955).

The theory that has been developed for rare-earth ions in crystals is here applied to the double nitrates. The paramagnetic resonance data and certain spectroscopic properties of the different rare-earth double nitrates, depending as they do on the crystalline electric field at a rare-earth ion, are related to the six parameters through which the field is defined. It is found that most of the experimental results can be fitted to values of the parameters that vary in a systematic fashion along the rare-earth series. A.

538.222 : 537.52

3026. PARAMAGNETIC RESONANCE OBSERVATIONS ON THE CONDENSED PRODUCTS OF ELECTRIC DISCHARGES THROUGH WATER VAPOR AND RELATED SUBSTANCES. R.Livingston, J.Ghormley and H.Zeldes.
J. chem. Phys., Vol. 24, No. 2, 483-4 (Feb., 1956).

Paramagnetic resonance was observed in the material formed by passing water (or D_2O or 90% H_2O_2) through an electric discharge and condensing the products on a liquid-nitrogen-cooled surface. The line at 23 000 Mc/s has a main peak at g = 2.0085 and can be ascribed to HO_2 formed (0.3%) as the material condensed. R.C.Murray

538.245

3027. FERROMAGNETIC DOMAIN NUCLEATION IN SILICON IRON. L.F.Bates and D.H.Martin.
Proc. Phys. Soc. B, Vol. 69, Pt 2, 145-52 (Feb., 1956).

Powder deposit patterns obtained by the authors on single crystals of 3% silicon iron are consistent with a description of the processes of domain phase creation in terms of nucleation at inclusions in the surfaces. Domain nucleation is discussed in relation to various magnetic properties. A.

538.247 : 621.318.2 : 621.317.4

3028. A PRECISION MEASURING ARRANGEMENT FOR RESEARCH ON THE AGEING OF PERMANENT MAGNETS. R.K. Tenzer.
Arch. tech. Messen, Issue No. 239 (Ref. J 66-5) 285-8 (Dec., 1955). In German.

A null method, using a ballistic galvanometer or fluxmeter, for the measurement of magnetic flux. The voltage pulse as the search coil is removed from the specimen is opposed by a similar pulse produced by a change of current in the primary coil of a mutual inductor, the secondary coil of which is in series with the search coil. The current change in the primary coil is so timed as to minimize the effects of the differing pulse shapes. An accuracy of 1 in 10^4 is claimed.
A.E.De Barr

538.248

3029. THE REMANENT MAGNETIZATION OF HAEMATITE POWDERS. E.P.Wohlfarth.
Phil. Mag., Vol. 46, 1155-64 (Nov., 1955).

Calculations are described of the remanent magnetization and the remanence after demagnetization as a function of field strength for powders of haematite, αFe_2O_3. The calculations are based on the assumptions that the powder particles are single domains and that their hysteretic properties are due to magnetocrystalline anisotropy with threefold symmetry in the basal crystal plane. The calculations are intended for eventual comparison with experiments now in progress. A.

538.27

3030. THE BEHAVIOR OF FERROMAGNETICS UNDER STRONG COMPRESSION. F.D.Stacey.
Canad. J. Phys., Vol. 34, No. 3, 304-11 (March, 1956).

Specimens in the form of thin disks have been subjected to strong compression simultaneously with high magnetic fields by means of a new design of permeameter, with which their magnetizations have been measured. Magnetization curves extending to saturation have been plotted for a number of materials at (non-hydrostatic) pressures up to 10 000 atm. The most interesting result is the strong increase in saturation magnetization shown by nickel and the nickel-copper alloys.
A.

538.27 : 538.614

3031. MAGNETIC ROTATORY POLARIZATION IN COPPER FERRITE AT 10 kMc/s. F.Mayer.
C.R. Acad. Sci. (Paris), Vol. 242, No. 1, 81-3 (Jan. 4, 1956). In French.

Reports results of measurements of the Faraday angle θ in a longitudinal static field H for both cubic spinel and quadratic structures. The θ, H curves resemble hysteresis loops, the former structure having a long and narrow loop and the latter a short and wide one with a "coercivity" value about 70 oersted. E.P.Wohlfarth

ELECTROMAGNETISM. ELECTRODYNAMICS 538.3/.5

538.3

3032. MECHANICAL FORCES ON A CURRENT-CARRYING CONDUCTING CYLINDER. E.E.Jones.
Amer. J. Phys., Vol. 24, No. 3, 131-5 (March, 1956).

The magnetostatic field due to an elliptic cylinder carrying steady current in a nonuniform magnetic field is determined through the use of magnetic vector potentials and complex potential functions. The resultant force and couple on the cylinder are deduced and their forms investigated in the particular cases when (i) the cylinder is of circular section, and (ii) when the external magnetic field possesses a certain type of symmetry. A.

538.3 : 519.2

3033. CLASSICAL ELECTRODYNAMICS AS A DISTRIBUTION THEORY. J.G.Taylor.
Proc. Cambridge Phil. Soc., Vol. 52, Pt 1, 119-34 (1956).

A precise distribution-theoretic formalism for the description of point charges interacting through a classical electromagnetic field is given. The distribution solutions of the Maxwell equations are shown to reduce to the Lienard—Wiechert fields, which are summable over the whole of space-time. It is not possible to obtain directly a unique field intensity, on the world lines, from these distribution solutions. A brief analysis shows that analytic continuation methods also do not give a unique field intensity on the world lines. The energy tensor for the field is a distribution which can only be rigorously defined in terms of the motions of the charges. Thus only the value of the field energy or momentum residing in any finite region of space-time can be given any meaning. Equations of motion for the charges may be derived from the field energy tensor, using the principle of conservation of total energy and momentum for the system. These equations agree with those obtained previously by Dirac. Also any canonical formalism in which the field potentials and the particle variables enter in an equivalent manner is not possible. The difficulty of the definition of products of distributions in the stress tensor does not occur. A.

538.3 : 532.51

3034. SOME EXACT SOLUTIONS OF THE LORENTZ INVARIANT PROBLEM OF THE MOTION OF TWO ELECTRIC FLUIDS. J.J.Gibbons.
Canad. J. Phys., Vol. 33, No. 12, 819-23 (Dec., 1955).

Methods of generating exact steady-state solutions for the flow of superimposed positive and negative fluids are developed for the cases of linear and cylindrical motion. The two fluids are assumed to be subject only to body forces arising from the total E and B fields. It is shown that the only axially symmetric

solutions are of cylindrical symmetry, i.e. rotating spheres or rings of charge cannot satisfy the equations where the two fluids overlap. A.

538.311

3035. MAGNETIC SYSTEMS ASSOCIATED WITH SYSTEMS OF CONSTANT ELECTRIC CURRENTS AND THEIR APPLICATION TO THE NUMERICAL CALCULATION OF FIELDS. E.Durand.
Ann. Phys. (Paris), Vol. 10, 883-907 (Nov.-Dec., 1955). In French.

A linear current has a magnetic shell associated with it. If a given current distribution is imagined to be broken down into a series of elementary tubes then superposition of the corresponding shells gives a ready means of working out the associated magnetic system. In this manner it is possible to define a scalar potential inside the currents. The great advantage of the scalar potential is to enable the steady-current problem to be brought into the same form as that of an electrostatics problem of known solution. A number of examples are worked out,including the complete calculation for a shielded solenoid. C.R.S.Manders

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56

3036. SOURCE REPRESENTATIONS FOR DEBYE'S ELECTROMAGNETIC POTENTIALS. A.Nisbet.
Physica, Vol. 21, No. 10, 799-802 (Oct., 1955).

Source representations for the Debye potentials of the electromagnetic field of radiating charges and currents are given which are valid at any point of space. These lead to a direct determination of multipole expansions, valid outside the source distribution, for the Debye potentials, obtained by Bouwkamp and Casimir (Abstr. 11229/1954) by an alternative method. A.

538.56

3037. GROWING ELECTROMAGNETIC WAVES. J.H.Piddington.
Phys. Rev., Vol. 101, No. 1, 9-14 (Jan. 1, 1956).

The growth of radio and other electromagnetic waves is considered in terms of the ion motions of Bailey's electromagneto-ionic theory, of a double electron stream and other factors. These conclusions are reached: (i) The electromagneto-ionic theory predicts spurious growing waves which do not correspond to any interchange of energy between gas and field but merely to the movements of the observer and emitter relative to the gas particles. It probably does not predict any real growing waves. (ii) The twelve different oscillatory modes inferred from the full dispersion equation correspond to four unreal waves and four pairs of real waves: two pairs of hydromagnetic waves (becoming radio waves as a limiting high-frequency case), one pair of modified sound waves and one pair of modified electron-sound waves. (iii) Electromagnetic wave growth may possibly result from one and only one process: the trapping of ions between potential troughs of the space-charge wave which is an integral part of some electromagnetic waves. After trapping, the ions give kinetic energy to the wave by one of two known processes. (iv) Ion drift motions may introduce important effects not indicated by the wave equations. A.

538.56 : 621.385.1.029.6

3038. GROWING ELECTRIC SPACE-CHARGE WAVES AND HAEFF'S ELECTRON-WAVE TUBE. J.H.Piddington.
Phys. Rev., Vol. 101, No. 1, 14-16 (Jan. 1, 1956).

A theory of "growing"electric space-charge waves in drifting, interpenetrating electron streams, or mixed ion and electron streams, has been developed by Pierce, Haeff and others to explain the operation of the electron-wave tube and other amplifying devices and perhaps also the origin of some solar radio emission. The theory is shown to be untenable, the growth predicted being spurious and due to misinterpretation of the dispersion equations. The waves which are thought to grow are evanescent waves being reflected back into an emitter which is moving through the gas. Only mathematically do they appear as real travelling waves with exponential growth. An alternative mechanism to explain the operation of the amplifying tubes is briefly described. A.

538.56 : 621.385.833

3039. GROWING WAVES DUE TO TRANSVERSE VELOCITIES. J.R.Pierce and L.R.Walker.
Bell Syst. tech. J., Vol. 35, No. 1, 109-25 (Jan., 1956).

Treats propagation of slow waves in two-dimensional neutralized electron flow in which all electrons have the same velocity in the direction of propagation but in which there are streams of two or more velocities normal to the direction of propagation. In a finite beam in which electrons are reflected elastically at the boundaries and in which equal d.c. currents are carried by electrons with transverse velocities $+u_1$ and $-u_1$, there is an antisymmetrical growing wave if $\omega_{p_2}^2 \sim (\pi u_1/W)^2$ and a symmetrical growing wave if $\omega_p^2 \sim \frac{1}{3}(\pi u_1/W)^2$. Here ω_p is plasma frequency for the total charge density and W is beam width. A.

538.56 : 532.5

3040. THE STABILITY OF THE FLOW OF AN ELECTRICALLY CONDUCTING FLUID BETWEEN PARALLEL PLANES UNDER A TRANSVERSE MAGNETIC FIELD. R.C.Lock.
Proc. Roy. Soc. A, Vol. 233, 105-25 (Dec. 6, 1955).

The stability under small disturbances is investigated of the two-dimensional laminar motion of an electrically conducting fluid under a transverse magnetic field. It is found that the dominating factor is the change in shape of the undisturbed velocity profile caused by the magnetic field, which depends only on the Hartman number M. Curves of wave-number against Reynolds number for neutral stability are calculated for a range of values of M; for large values of M the calculations are similar to those which determine the stability of ordinary boundary-layer flow. The critical Reynolds number is found to rise very rapidly with increasing M, so that a transverse magnetic field has a powerful stabilizing influence on this type of flow. A.

538.56 : 532.51

3041. HYDROMAGNETIC STABILITY OF A CURRENT LAYER. R.E.Loughhead.
Austral. J. Phys., Vol. 8, No. 3, 319-28 (Sept., 1955).

The hydromagnetic stability of a uniform current flowing along a magnetic field and confined within a pair of parallel planes is discussed by the method of normal modes. The condition for marginal stability is derived and discussed with reference to two special cases. It is also shown that the velocity of Alvén waves along a magnetic field in a region bounded by parallel planes is reduced due to the inertia of the surrounding medium. A.

538.561

3042. ON THE THEORY OF STATIONARY WAVES IN PLASMAS. N.G.Van Kampen.
Physica, Vol. 21, No. 12, 949-63 (Dec., 1955).

Existing theories of stationary plasma oscillations lead to a dispersion equation involving an integration across a pole. It is here shown that this difficulty is of purely mathematical origin, and can be overcome by a proper treatment. This treatment leads to a complete set of stationary solutions, which are much more numerous than the usual plasma oscillations. In particular, their wavelengths and frequencies are not connected by a dispersion equation, but independently assume all real values. Special superpositions of these stationary solutions correspond to the usual plasma oscillations.

They constitute slightly damped plane waves, which do obey the dispersion equation, the integral being interpreted as a Cauchy principal value. An arbitrary initial distribution behaves (after a short transient time) like a superposition of such waves, as far as the density is concerned. A.

538.566

3043. THE DIFFRACTION ON A CONDUCTING WEDGE. THE GENERAL SOLUTIONS FOR DIPOLE FIELD. R.Teisseyre.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 869-71 (Oct., 1955).

The solution is obtained by a generalization of the method given by Senior (Abstr. 7801/1953) for the diffraction by a perfectly conducting half-plane. L.Pincherle

538.566 : 621.396.674.3

3044. PROPAGATION OF TRANSIENT FIELDS FROM DIPOLES NEAR THE GROUND. H.Poritsky.
Brit. J. appl. Phys., Vol. 6, No. 12, 421-6 (Dec., 1955).

The propagation in air and underground of an electromagnetic wave originated by a current pulse in a small aerial located at or near the surface of the ground is studied. The treatment is based upon the resolution of a spherical wave into proper plane waves, this resolution being analogous to one used by Weyl (1919) for the steady-state case. A double-integral representation is obtained for (the Hertz potential of) the field. For a vertical dipole on the ground, one of the integrations is carried out above ground and in a certain conical range underground, while the second integration is carried out for special directions and locations. A.

538.566.2 : 537.226.2

THE REFRACTIVE INDICES OF WATER VAPOUR, AIR, OXYGEN, NITROGEN AND ARGON AT 72 kMc/s. See Abstr. 2059

538.566.2

3045. ON THE ELECTRODYNAMICS OF TURBULENT IONIZED MEDIA. T.Kahan.
C.R. Acad. Sci. (Paris), Vol. 241, No. 24, 1726-7 (Dec. 14, 1955). In French.

The scattering of radio waves due to random fluctuations in the refractive index of the ionosphere is discussed and a modification to the normal scattering equation suggested. A.J.Egginton

538.566.3 : 621.396.11

3046. MAGNETO-IONIC TRIPLE SPLITTING OVER DELHI. S.N.Mitra.
J. Instn Telecomm. Engrs (New Delhi), Vol. 1, No. 3, 124-9 (Sept., 1955).

Presents some observations of the rare occurrence of triple magneto-ionic splitting over Delhi. The various possible causes for the occurrence of this phenomenon at the low geomagnetic latitude of Delhi have been discussed. It has been indicated that the triple splitting is likely to be caused by the longitudinal propagation of the ordinary ray associated with an increase in the collisional frequency of the ionospheric layers. A.

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

3047. ON THE THEORY OF PLASMA OSCILLATIONS IN METALS. H.Kanazawa.
Progr. theor. Phys., Vol. 13, No. 3, 227-42 (March, 1955).

The effect of the crystal lattice on plasma oscillations is investigated. The results which have been obtained by Wolff on a semiclassical basis are derived quantum-mechanically. The interaction between electrons and plasma oscillations causes interband transitions besides intraband transitions. The interband transitions give rise to frequency broadening in addition to a shift in frequency. This explains the differences in behaviour between various metals observed by Ruthemann, Lang and other workers. A.

539.11

3048. MOMENTUM OF PHONONS. I. G.Süssmann.
Z. Naturforsch., Vol. 11a, No. 1, 1-14 (1956). In German.

An analysis of the de Broglie relation applied to phonons reveals that the difference between the lattice momentum and the "pseudo-momentum of the sound" is an approximately constant magnitude whose sine is strictly constant. The possibility is analysed of the $\sin^{-1}$ of a constant observed magnitude changing continuously with time. The "pseudo-momentum" being explained as due to "infinitesimal dislocations" of the lattice, it becomes possible to understand both its similarity and dissimilarity to momentum (infinitesimal translations). The difference between these two magnitudes consists mainly in a cyclic permutation of atoms. F.Lachman

539.11

3049. COHESIVE ENERGY OF POTASSIUM. S.Berman, J.Callaway and R.D.Woods.
Phys. Rev., Vol. 101, No. 5, 1467-8 (March 1, 1956).

The cellular method is applied to a calculation of the cohesive energy of metallic potassium. The crystal potential is taken from a self-consistent field with exchange for the potassium ion. An approximate exchange interaction between the valence and the core electrons is included. The cohesive energy is found to be 18.5 or 19.3 cal/mole according as Pines' or Wigner's expression for the correlation energy is used, and the effective mass to be 86% of the free-electron mass. The experimental value is 22.6 cal/mole. A.

539.11

3050. VACANCIES IN METALLIC SODIUM. S.Machlup.
J. chem. Phys., Vol. 24, No. 1, 169-70 (Jan., 1956).

Theoretical. The scattering cross-section for free electrons by a vacancy, represented by a screened Coulomb potential with Z = 1, is calculated to be 4.0×10^{-16} cm^2, corresponding to a resistivity of 1.5 microhm.cm per atomic % of vacancies. For interstitials, the same model gives a resistivity contribution of 3.2 microhm.cm/atomic %. The observed resistance anomaly of 0.4 ohm.cm at the melting point can be ascribed to an equilibrium vacancy concentration 0.25 atomic %, compared to 0.5 atomic % deduced from the specific heat anomaly. J.Hawgood

539.11

3051. INTERACTION OF CONDUCTION ELECTRONS AND NUCLEAR MAGNETIC MOMENTS IN METALLIC SODIUM. T.Kjeldaas, Jr and W.Kohn.
Phys. Rev., Vol. 101, No. 1, 66-7 (Jan. 1, 1956).

The electronic wave-function at the Fermi surface of metallic Na has been calculated. The resulting value of $|\Psi|^2$ at a Na nucleus is discussed with reference to measurements of the Knight shift and the paramagnetic susceptibility. A.

539.11

3052. NUCLEAR SPIN-LATTICE RELAXATION TIME IN COPPER AND ALUMINUM. A.G.Redfield.
Phys. Rev., Vol. 101, No. 1, 67-8 (Jan. 1, 1956).

Nuclear spin-lattice relaxation times of Al^{27} in pure Al and Cu^{63} in annealed pure Cu have been measured at 2 and 4.2°K, using the adiabatic fast-passage technique suggested by L.E.Drain. At 4.2°K, $T_1 = 260 \pm 100$ milliseconds for copper and 370 ± 40 milliseconds for aluminium. The relaxation time is apparently inversely proportional to temperature, as predicted by Korringa, from 2 to 300°K. A.

539.11

3053. SIGNIFICANCE OF HALL EFFECT MEASUREMENTS ON ALLOYS. B.R.Coles.
Phys. Rev., Vol. 101, No. 4, 1254-5 (Feb 15, 1956).

Hall effect data for a number of alloys are examined in the light of the accepted theory of this effect. It is concluded that assumptions made about the relaxation time which seem appropriate when scattering by lattice vibrations predominates are not valid when scattering by solute atoms becomes significant. A.

539.11 : 536.212

THE EFFECT OF FREE ELECTRONS ON LATTICE CONDUCTION. See Abstr. 2029

MOLECULES 539.13

539.13

3054. ON THE ENERGY DEPENDENCE OF INELASTIC MOLECULAR COLLISION PROBABILITIES. B.Widom.
J. chem. Phys., Vol. 23, No. 12, 2377-80 (Dec., 1955).

It is pointed out that because of the uncertainty principle, cross-sections for inelastic molecular collisions vanish at the threshold, in sharp distinction to their classical behaviour. The dependence of the inelastic collision probability on the energy is deduced and found to be of the form

$$k^{2l+1}(a_0 + a_2k^2 + a_4k^4 + \ldots),$$

where k and l are the wave-number and the total angular momentum quantum number, respectively, which describe the incident wave in case of de-excitation or the emergent wave in case of excitation. It is shown that because of this property of inelastic collisions, the pre-exponential factor in the collision theory of bimolecular kinetics contains only non-negative integral powers of the temperature. A.

539.13 : 533.7

3055. INTERMOLECULAR POTENTIAL ENERGY OF DIPOLAR GASES FROM HEAT CAPACITY DATA. D.R.Douslin and G.Waddington.
J. chem. Phys., Vol. 23, No. 12, 2453-4 (Dec., 1955).

There is excellent agreement between experimental (McCullough et al., J. Amer. Chem. Soc., Vol. 76, 4791, Oct. 5, 1954) and theoretical values of the pressure derivative of the vapour heat capacity and the second virial coefficient for nitromethane, the theoretical values being obtained from Stockmayer's equation for the second virial coefficient of dipolar gases, values of the heat capacity function for which are tabulated. R.C.Murray

539.132

3056. VALIDITY OF THE ASSUMPTION OF TWO-BODY INTERACTIONS IN MOLECULAR PHYSICS. I. R.T.McGinnies and L.Jansen.
Phys. Rev., Vol. 101, No. 4, 1301-6 (Feb. 15, 1956).

The energy of interaction between a group of two spherical atoms (AB), which are close together, and an identical atom C, which is farther away, is evaluated by applying second-order perturbation theory. The calculations are carried out for three hydrogen atoms with parallel spins and for three helium atoms. Permutations of electrons between atoms A and B are taken into account by using an antisymmetric zero-order wave-function for the group (AB). It is found that, in general, second-order interactions between (AB) and C are not equal to a sum over isolated pairs (AC) and (BC); in practically all cases the second-order interactions are weaker than when calculated on an additive basis. Numerical results are given for three special cases: a linear array, a right triangle, and an integrated effect, as functions of the distances between the three atoms. A comparison is made with the triple-dipole energy as calculated by Axilrod. It is shown than the nonadditive effect calculated in this paper is usually considerably larger than the triple-dipole energy for the same triangular configuration and that it may contribute significantly to the stability of the face-centred cubic lattice of the heavy rare gases. A.

539.132

3057. SPECTROSCOPIC CONSTANTS OF MOLECULES IV. SIMILARITIES IN GROUND STATE VIBRATION FREQUENCIES OF ISOELECTRONIC DIATOMS. Y.P.Varshni and K.Majumdar.
Indian J. Phys., Vol. 29, No. 6, 285-91 (June, 1955).

For Pt III, see Abstr. 8117 (1955). Resemblances in ground-state vibration frequencies of isoelectronic diatoms belonging to the same molecular group and having "reversed" closed shells, have been investigated. A

539.132

3058. COMMENTS ON THE NUMERICAL EVALUATION OF MOLECULAR INTEGRALS FOR SMALL INTERNUCLEAR DISTANCES. W.Bingel.
Z. Naturforsch., Vol. 11a, No. 1, 85-8 (1956). In German.

A new representation of the nuclear attraction integral K is proposed in terms of an auxiliary function $C_n(\rho)$, more suitable for small ρ (ρ is internuclear distance). A table is given for $C_n(\rho)$, $n = 0 - 6$, $\rho = 0(0.1)1$. Interpolation also is more convenient in terms of the C_n. J.Jacobs

539.132

3059. THE PERTURBATIONS IN THE NEAR ULTRA-VIOLET BAND-SYSTEM (D–X) OF SILICON MONOSULPHIDE. G.Nilheden.
Ark. Fys., Vol. 10, Paper 2, 19-36 (1955).

The rotational analysis of the near ultraviolet band system D $^1\Pi$–$X^1\Sigma^+$ has been extended to higher levels. Eight new bands have been analysed, namely the 7,0, 8,0, 8,1, 8,2, 9,1, 9,2, 10,1, and 10,2 bands. With special attention to the perturbations in the D state nine bands have been reanalysed, namely the 2,0 3,0, 4,0, 4,1, 5,0, 5,1, 6,0, 6,1, and 7,1 bands. The perturbations investigated arise from interactions with three electronic states, a $^3\Sigma^-$ state, a $^1\Pi$ or $^1\Delta$ state and a $^1\Sigma^-$ state. For the $^1\Pi$ or $^1\Delta$ state it has been possible to determine the v numbering. For the other two states it is impossible to give the v numbering, but in spite of that fairly good information has been obtained. For the $^3\Sigma^-$ state the constants derived are: $B_{e+v} = 0.221_8 - 0.002_8v$; $\omega'_e \geq 407_3$; $x'_e\omega'_e = 1.7_7$. For the $^1\Pi$ or $^1\Delta$ state: $B_{v'} = 0.226_9 - 0.002_8(v' + \frac{1}{2})$; $\omega'_e = 439_0$; $x'_e\omega'_e = 3.9_7$. For the $^1\Sigma^-$ state: $B_{i+v} = 0.213_3 - 0.001_8v$; $\omega'_e \geq 404._9$; $x'_e\omega'_e = 1.1_8$. Moreover, interactions with a fourth perturbing state seem to be present. For the moment no information can be given concerning this state. To get this information the analysis must be extended to even higher levels. A.

539.132

3060. VIBRATION-ROTATION BANDS AND ROTATIONAL CONSTANTS OF DIDEUTEROACETYLENE. J.Overend and H.W.Thompson.
Proc. Roy. Soc. A, Vol. 232, 291-309 (Nov. 8, 1955).

Nine vibrational absorption bands of dideutero-acetylene have been examined with very high resolving power. The rotational constants have been determined for the vibrational level concerned, and the coefficients α_i have been determined with more convincing accuracy than previously. In some of the band the Q branches have been resolved, so that the l-doubling coefficients q_i could be derived, and details could be established about the doublet components in some Π levels. The results emphasize the need of high resolution if the vibrational assignments are to be unambiguous, and if reliable values of the rotational constants are to be derived. A value of B_e has been obtained, and the vibrational anharmonicity coefficients have been considered briefly. Estimates of the centrifugal stretching constants D_i in different vibrational states have been made, and one anomalous case has been found. A

539.132

3061. ON THE CALCULATION OF THE CHARACTERISTIC VALUES AND VECTORS FOR VIBRATIONAL SECULAR EQUATIONS. T.Shimanouchi.
J. chem. Phys., Vol. 23, No. 12, 2465 (Dec., 1955).

A convenient form of the initial vector V, to be used in the Hamilton—Cayley indirect expansion method, is $(h_{11}, h_{22} \ldots . h_{nn})$ where h_{ii} is the estimated value of $a_{ii}^{-(n/2)}$, a_{ii} being the i^{th} diagonal element of the secular matrix $|a|$. The normal modes can also be determined accurately by this method. J.Jacobs

539.132

3062. SUBSTITUTED ETHANES. IV. THE ROTATIONAL ISOMERS OF 1, 1, 2, 2-TETRACHLOROETHANE: ASSIGNMENTS TO THE NORMAL VIBRATIONS. J.P.Zietlow, F.F.Cleveland and A.G.Meister.
J. chem. Phys., Vol. 241, No. 1, 142-6 (Jan., 1956).

The wave-numbers of the normal vibrations of trans 1, 1, 2, 2-tetrachloroethane and some of the fundamentals of the deuterated molecule are calculated by the Wilson FG matrix method. The infrared spectrum of 1, 1, 2, 2-tetrachloroethane has been obtained from 530 to 4000 K. Complete assignments of all the observed Raman and infrared bands have been made and some unobserved fundamentals have been computed. A.

539.132

3063. ROTATION-RESISTING ENERGY BARRIER IN THE NITRIC ACID MOLECULE. H.Cohn, C.K.Ingold and H.G.Poole.
J. chem. Phys., Vol. 24, No. 1, 162 (Jan., 1956).

Points out that the barrier height 9-10 kcal/mole obtained by Palm and Kilpatrick (Abstr. 9619/1955) from the data of Cohn et al., agrees with the value previously obtained by the latter authors. J.Hawgood

539.132

3064. ON THE USE OF LOCAL SYMMETRY IN ANALYZING THE INFRARED SPECTRA OF COMPLEX MOLECULES. A.D.Liehr.
J. chem. Phys., Vol. 24, No. 1, 162-3 (Jan., 1956).

Theoretical. The method is applicable to molecules which can be resolved into units of high symmetry, the interactions between units being small, or to systems slightly perturbed from high symmetry. It is applied to binuclear metal carbonyls, $C_5H_5X(CO)_nXC_5H_5$, which can be treated as a perturbation of a planar system whose normal coordinates are easily calculated. The predicted relative intensities of the C—O stretching modes agree with experiment. J.Hawgood

539.132

3065. ABSOLUTE INFRARED INTENSITIES OF VIBRATION BANDS IN AMMONIA AND PHOSPINE. D.C.McKean and P.N.Schatz.
J. chem. Phys., Vol. 24, No. 2, 316-25 (Feb., 1956).

The absolute absorption intensities of the fundamental vibration bands in ammonia and phosphine have been measured. Normal coordinates are calculated for each of the vibration and the intensities interpreted in terms of bond moments μ and their derivatives $\partial\mu/\partial r$. Values of $\partial\mu/\partial r$ for for the NH and PH bonds in the A_1 mode are 0.6 and 1.2 D/A, respectively; in the E mode the corresponding values are 0.2 and 0.8 D/A. Values of the vibrational bond moments found are 1.0 D (A_1) and 0.5 D (E) for the NH bond; 0.7 or 0.5 D (A_1) and 1.2 or 0.6 D (E) for the PH bond. The relation of these vibrational bond moments to the molecular dipole moment and the moment ($\mu_{u.p.}$) of the unshared pair of electrons is discussed in detail. After corrections have been applied for changes in magnitude and direction of $\mu_{u.p.}$ during the vibrations, the results for NH_3 are compatible with the following static moments:

$$\mu_{NH} \sim 0.7\,D(H^+), \mu_{u.p.} \sim 0.7\,D.$$

The data for PH_3 are less internally consistent. "Likely" moments, taken from the A_1 bending vibration, are

$$\mu_{PH} \sim 0.2(H^+), \quad \mu_{u.p.} \sim 0.2\,D$$ A.

539.132 : 535.371

3066. VIRTUAL OSCILLATORS IN THE METALLIC MODEL OF LUMINESCENT MOLECULES. A.Jabłoński.
Nuovo Cimento (Ser 10), Vol. 2, No. 5, 995-1000 (Nov., 1955).

The character of virtual oscillators connected with electronic transitions responsible for absorption and fluorescence bands of some luminescent molecules (fluorescein, rhodamine B, euchrisine, trypaflavine and acridine yellow) is determined by using the transition moments, calculated by Laffitte on the basis of the metallic model of molecules. Contrary to the hitherto prevailing views, according to which these oscillators should be linear, the metallic model yields non-linear oscillators for the above molecules, viz. very anisotropic flat oscillators. Hence it follows that the theoretical values of the principal polarization of fluorescence P_p of these molecules are less than they would be in the case of linear oscillators, viz. P_p is less than 0.5. The calculated values of P_p are: 0.47 for fluorescein, 0.49 for rhodamin B and 0.485 for euchrisine, trypaflavine and acridine yellow. The differences between these values and those actually observed are believed to be due, at least partially, to the depolarizing effect of torsional vibrations of luminescent molecules. Assuming the whole difference to be due to torsional vibrations, the upper limit is estimated of the dependence of this effect on temperature. The dependence appear to be rather feeble (since the whole effect is small), but seems to be detectable. One of the aims of the present paper is to show the usefulness of the notion of the "spatial virtual oscillator", of which the "flat oscillator" and the "linear oscillator" are particular cases. A.

539.132

3067. FREE RADICALS BY MASS SPECTROMETRY. VIII. THE IONIZATION POTENTIALS OF PARA-, ORTHO-, AND META-XYLYL RADICALS. J.B.Farmer, F.P.Lossing, D.G.H.Marsden and C.A.McDowell.
J. chem. Phys., Vol. 24, No. 1, 52-5 (Jan., 1956).

For Pt VI, see Abstr. 11305 (1954). The vertical ionization potentials of the para-, ortho- and meta-xylyl radicals as measured by electron impact are 7.46 ± 0.05, 7.61 ± 0.05 and 7.65 ± 0.03 V, respectively. The thermal dissociation of the para- and ortho-xylyl radicals to form the quinodimethanes has been observed. The meta-xylyl radical was found to have a considerably greater thermal stability. A.

539.132

3068. SPIN-ORBITAL INTERACTIONS IN MOLECULAR IONS. C.A.McDowell and D.C.Frost.
J. chem. Phys., Vol. 24, No. 1, 173-4 (Jan., 1956).

Mulliken's interpretation of the limits of the two Rydberg series in the far u.v. spectrum of CH_3I, CH_3Br as due to $^2E\ 3/2$, $^2E\ ½$ spin-orbital components of the ground states of corresponding ions has been confirmed. The two spin-orbital components of the ^2E states of CH_3I^+, CH_3Br^+, I_2^+ and others have been resolved and the magnitude of the splitting of their ground states determined. J.Jacobs

539.132 : 541.28

EXCITATION AND DISSOCIATION OF MOLECULES DUE TO β DECAY OF A CONSTITUENT ATOM. See Abstr. 2514

539.132

3069. MOLECULAR ORBITAL APPROXIMATION TO ELECTRON COUPLED INTERACTION BETWEEN NUCLEAR SPINS. H.M.McConnell.
J. chem. Phys., Vol. 24, No. 2, 460-7 (Feb., 1956).

The general formulae obtained by Ramsey for the indirect second-order magnetic coupling of nuclear spins by electron spin and orbital magnetic moments in $^1\Sigma$ molecules are used together with an antisymmetrized product of molecular spin

orbitals to obtain a set of general equations for nuclear spin couplings which only involve (a) the individual molecular orbitals, and (b) rotationally invariant one and two electron space operators. By approximating the molecular orbitals with linear combinations of atomic orbitals quite tractable formulae are obtained for "long-range" nuclear spin-spin couplings, i.e., couplings between nuclei separated by two, three, or more bond lengths. The application of these formulae are illustrated by the development of an approximate formula for proton-proton coupling constants in terms of interproton bond orders, the application of this formula to methane, as well as some qualitative considerations of F^{19}—F^{19} coupling constants in tetrafluoroethylene. In general nuclear spin couplings between protons not directly bonded to one another arises primarily through hyperfine interactions between protons and pairs of electron spins. In hydrocarbons long-range bond orders between protons, $\eta_{HH'}$, can be estimated from observed proton spin couplings by the equation, $\eta_{HH'}{}^2 = 0.5 \times 10^{-2} J_{HH'}$ (in. sec^{-1}). In fluorocarbons (and probably many other substances) nuclear couplings are due to the combined effects of hyperfine electron orbital and electron spin interactions with F^{19} nuclei. Electron exchange effects are important for both two-electron spin and orbital contributions to nuclear coupling. A.

539.132

3070. NUCLEAR MAGNETIC RESONANCE SPECTRA OF CONJUGATED AROMATIC HYDROCARBONS. H.J.Bernstein and W.G.Schneider.
J. chem. Phys., Vol. 24, No. 2, 468-9 (Feb., 1956).

539.132

3071. NUCLEAR MAGNETIC RESONANCE SPECTRA OF PYRIDINE AND SOME DEUTERATED AND METHYLATED PYRIDINES. H.J.Bernstein and W.G.Schneider.
J. chem. Phys., Vol. 24, No. 2, 469-70 (Feb., 1956).

By the use of D and CH_3 substitution the chemical shifts in the n.m.r. spectra of pyridine are shown to be +292 (ortho), +247 (para) and +235 (meta) c/s for the protons at the positions indicated, cyclohexane at 40 Mc/s being taken as standard. D.H.Whiffen

539.132

3072. NUCLEAR SPIN COUPLING CONSTANTS IN HALOGENATED OLEFINS. H.M.McConnell, C.A.Reilly and A.D.McLean.
J. chem. Phys., Vol. 24, No. 2, 479-80 (Feb., 1956).

Tabulates and assigns H and F coupling constants from the nuclear magnetic resonance spectra of substituted ethylenes. D.H.Whiffen

539.132

3073. HYDRATION EFFECTS IN CHLORINE-35 NUCLEAR SPIN RESONANCE. J.E.Wertz.
J. chem. Phys., Vol. 24, No. 2, 484 (Feb., 1956).

Evidence for the infrequent exchange of hydrate water with solvent in aqueous solutions of paramagnetic ions has been found from the fact that the 0.2 gauss line width between points of maximum slope for $(Cl^{35})^-$ in aqueous NaCl is increased by paramagnetic ions and the amplitude lessened. The relative signal amplitudes compared with those from pure NaCl solution for various ions in 0.1 M concentration in 3 M NaCl decrease in the order Mn^{2+}, Cu^{2+}, Fe^{3+}, Ti^{3+}, Ni^{2+}, Co^{2+}, Cr^{3+} which is the order of decreasing effectiveness in relaxation and not of decreasing magnetic moment. R.C.Murray

539.132

3074. EFFECT OF PRESSURE ON THE NUCLEAR QUADRUPOLE RESONANCE OF Cl^{35} IN $HgCl_2$. D.Dautreppe and B.Dreyfus.
C.R. Acad. Sci. (Paris), Vol. 242, No. 6, 766-8 (Feb. 6, 1956). In French.

The pressure coefficients of the quadrupole resonance frequencies of solid $HgCl_2$ are -7.2 kc/s per 100 $kg.cm^{-2}$ for the 22.07 Mc/s absorption and -5.1 kc/s per 100 $kg.cm^{-2}$ for the 22.26 Mc/s absorption. The two frequencies arise from different Hg—Cl distances in the crystal lattice and much of the pressure coefficient is due to a shortening of the Hg—Cl bonds. D.H.Whiffen

539.132

3075. ELECTRONIC POPULATION ANALYSIS OF LCAO-MO MOLECULAR WAVE FUNCTIONS. II. OVERLAP POPULATIONS, BOND ORDERS AND COVALENT BOND ENERGIES. R.S.Mulliken.
J. chem. Phys., Vol. 23, No. 10, 1841-6 (Oct., 1955).

LCAO molecular orbital overlap populations give in general much more flexible and widely useful measures of the non-Coulombic parts covalent of bond energies than do LCAO bond orders. They are immediately applicable to both π and σ bonds, including bonds involving hybrid AO's of all kinds, and they take account directly of the effects of variations in bond length on bond strength. In the last section of this paper, a number of ways of defining LCAO bond orders are reviewed, and their advantages and disadvantages discussed. If all LCAO parameters β are assumed proportional to corresponding overlap integrals S times suitable mean atomic ionization energies $\bar{I}$, a simple general approximate formula for covalent resonance energies is obtained in terms of partial overlap populations and $\bar{I}$'s, including one or two empirical coefficients. This formula indicates that forced hybridization (to be discussed in Pt III) due to inner shells should make important negative contributions to bond energies. The application of the formula to H_2, CO and H_2O is discussed. The assumption of proportionality of β values to $S\bar{I}$ values may be useful also in estimating unknown β values. For Pt I, see Abstr. 1450 (1956). A.

539.132

3076. SUPPLEMENTARY COMMENTS ON THE "ELECTRONIC STRUCTURE OF THE AMYLOSE—IODINE COMPLEX" H.Murakami.
J. chem. Phys., Vol. 23, No. 10, 1979 (Oct., 1955).

Even if the pyranose ring in the glucose residue exists in chain form II, two models for the helical amylose may arise. It is shown that electronic interaction between oxygen and iodine is possible, confirming earlier conclusions by the author. J.Jacobs

539.13

3077. MOLECULAR ORBITAL PERTURBATION THEORY. I. A PERTURBATION METHOD BASED ON SELF-CONSISTE ORBITALS. J.A.Pople.
Proc. Roy. Soc. A, Vol. 233, 233-41 (Dec. 20, 1955).

Develops a method of investigating changes in the electronic structure of a molecule caused by a perturbation such as a substituent or the field of another particle. The method is based on a Hamiltonian including electron interaction. The total wave-function for the perturbed molecule is written as a linear combination of approximate self-consistent molecula orbital functions for the ground and excited states of the unperturbed system. First- and second-order expressions for changes in energy and charge distribution are given which ar generalizations of results previously obtained using an independent-electron model. See also erratum in Vol. 234, Feb. 2 1956. A

539.13

3078. MOLECULAR ORBITAL PERTURBATION THEORY. II. CHARGE DISPLACEMENT AND STABILIZATION IN CONJUGATED MOLECULES. J.A.Pople and P.Schofield.
Proc. Roy. Soc. A, Vol. 233, 241-7 (Dec. 20, 1955).

The general perturbation method outlined in Pt I is used to study energy and charge distribution changes caused by inductive and electromeric-type perturbations in conjugated molecules. Self-consistent orbitals for the unperturbed systems are found by approximating electron interaction

integrals and are used as a basis for the perturbed systems. It is found that the change of charge distribution caused by an inductive substituent in benzene is similar to that predicted by the independent-electron model. Second-order perturbation theory is used to discuss electromeric displacements in which lone pair electrons take part in conjugation. A.

539.132

3079. MAXIMAL ORTHOGONAL ORBITALS. G.W.Pratt, Jr and S.F.Neustadter.
Phys. Rev., Vol. 101, No. 4, 1248-50 (Feb. 15, 1956).

A set of orthogonal orbitals has been constructed from a given set of nonorthogonal orbitals so that the projection of the configuration in which each nonorthogonal orbital is singly occupied upon the configuration in which each corresponding orthonormal orbital is singly occupied has maximum amplitude. These orthogonal functions are referred to as maximal orthogonal orbitals. If, instead of maximizing the probability of the corresponding configuration in the v's, one maximizes the magnitude of the sum of the projections of each u on its corresponding orthogonal orbital, then Löwdin's set of orthogonal functions is the solution. Löwdin's functions differ from the maximal orthogonal orbitals only in third and higher order terms in the overlap matrix. A.

539.132

3080. CALCULATION OF DEPOLARIZATION FACTORS OF THE RAMAN LINES OF CBr_3X MOLECULES. R.H.Krupp, S.M.Ferigle and A.Weber.
J. chem. Phys., Vol. 24, No. 2, 355-7 (Feb., 1956).

The depolarization factors of CBr_3Cl have been measured by techniques described in the literature and the depolarization factors of the totally symmetric vibrations of CBr_3H, CBr_3D and CBr_3Cl have been computed using expressions for the spur and anisotropy of the polarizability tensor given previously. The associated normal coordinate treatment uses the Wilson FG-matrix technique. Calculated and observed depolarization factors agree well for stretching but not for the bending modes, as has been shown to be the case in similar molecules. A.

ATOMS. NUCLEUS. ISOTOPES 539.15

539.152 : 539.153 : 539.17

3081. GENERAL FORMULA OF THE RACAH COEFFICIENT. M.Sato.
Progr. theor. Phys., Vol. 13, No. 4, 405-14 (April, 1955).

It is shown that the general formula of the Racah coefficient can be expressed symbolically as a binomial expansion by reducing the sum of fractions involved in the general formula given by Racah. Similar formulae to Biedenharn's are given for e = 3, 7/2, 4 and 9/2. A.

539.152.1

3082. ON THE FOUNDATION OF THE UNIFIED NUCLEAR MODEL. I. T.Marumori, J.Yukawa and R.Tanaka.
Progr. theor. Phys., Vol. 13, No. 4, 442-54 (April, 1955).

An attempt is made to give the foundation of the model, which describes the nucleus as a system having a shell structure and capable of performing oscillations in shape. A.Bohr's model is analysed, making use of the results obtained. Throughout the paper emphasis is laid on making the physical image clear; more general mathematical procedure and discussion of the nuclear potential will follow. A.

539.152.1

3083. ISOTOPE SHIFTS AND NUCLEAR CHARGE DISTRIBUTIONS. A.S.Reiner.
Physica, Vol. 21, No. 10, 783-95 (Oct., 1955).

A general expression for the isotope shift is given. Compared with previous treatments a decrease of the volume shift resulted for a homogeneous charge distribution. Model factors for various classes of charge distributions are given for the volume and the distortion shift. The effect of nuclear compressibility is revised. The case of Pb is investigated and a tentative discrimination between different charge distributions leads to a homogeneous charge distribution with small deviations of the density in the surface region. A.

539.152.1

3084. ON THE DESCRIPTION OF COLLECTIVE MOTION BY THE USE OF SUPERFLUOUS CO-ORDINATES. H.J.Lipkin, A.de Shalit and I.Talmi.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 773-98 (Oct., 1955).

By introducing superfluous co-ordinates a method is demonstrated for treating the problem of combined collective and individual particle aspects of nuclear structure. The application to the case of the centre of mass gives a simple exposition of the method and rigorously defines conditions for the validity of the usual shell-model assumptions regarding the centre of mass. The application to rotation gives results similar to those obtained by A.Bohr using a hydrodynamical model and by Inglis using a classical rotating shell model. The present treatment is rigorous except for the fundamental shell-model assumption, the replacement of the inter-particle potential by a single-particle potential which may not be spherically symmetric. A.

539.152.1

3085. CENTRE-OF-MASS EFFECTS IN THE NUCLEAR SHELL-MODEL. J.P.Elliott and T.H.R.Skyrme.
Proc. Roy. Soc. A, Vol. 232, 561-6 (Nov. 22, 1955).

An examination is made of the possible errors that may arise in nuclear shell-model calculations by failing to separate out centre-of-mass motions from the internal motions of the system; a central oscillator potential is used to make possible a simple analysis. The most important effect is the appearance of spurious states that do not refer to the internal motion at all; these must be considered whenever the state is described by two or more unclosed shells (in the sense of L-S coupling), as, for example, in the excited states of O^{16}. A.

539.152.1

3086. THE CONDITIONS OF EXISTENCE OF NUCLEAR ROTATIONAL SPECTRA. C.Marty.
Nuclear Physics, Vol. 1, No. 2, 85-100 (1956). In French.

Within the framework of the unified model, a perturbation method is devised which allows the study of nuclear rotational spectra under quite general conditions, in particular without assuming that the nucleons coupled to the core are on well-defined orbitals. It is possible to treat cases where the core is asymmetric or possesses an axis of symmetry and to show that nuclear rotational spectra depend on two degrees of freedom if the core is asymmetric and one if the core has an axis of symmetry. The wave functions of the system are studied in detail. A.

539.152.1

3087. NUCLEAR SURFACE EFFECTS. R.A.Berg and L.Wilets.
Phys. Rev., Vol. 101, No. 1, 201-4 (Jan. 1, 1956).

The surface of the nucleus is treated by a phenomenological and self-consistent statistical method, neglecting Coulomb effects, in an attempt to correlate such nuclear properties as the volume energy, surface energy, falloff distance, and mean radius. Assuming a value of about 3.3×10^{-13} cm for the surface thickness the authors estimate the nuclear compressibility to be of the order of $125A + 210A^{2/3}$ MeV. A thinner nuclear surface (the experimental value is 2.5×10^{-13} cm) would lead to larger values for the compressibility and conversely. The nuclear potential is found to extend about 0.7×10^{-13} cm further in radius than the nuclear density. A.

539.152.1

3088. INTERMEDIATE COUPLING IN THE 1 p-SHELL. D.Kurath.
Phys. Rev., Vol. 101, No. 1, 216-24 (Jan. 1, 1956).

The region between He^4 and O^{16} is treated for the case of intermediate strength of spin-orbit coupling and central two-body interaction. Energy levels are presented as a function of the relative coupling strength parameter, a/K. Static electromagnetic moments are also computed as functions of a/K. Comparison with experimental results gives a fairly good picture, and determines a definite behaviour for a/K as a function of mass number. A possible interpretation of this behaviour is suggested. A.

539.152.1

3089. INTERPRETATION OF SOME OF THE EXCITED STATES OF 4n SELF-CONJUGATE NUCLEI. H.Morinaga.
Phys. Rev., Vol. 101, No. 1, 254-8 (Jan. 1, 1956).

An attempt is made to give a general account for some of the excited levels of 4n-type self-conjugate light nuclei, especially for characteristic low-lying 0^+ levels and also for the 2^+ levels which appear not too far above the 0^+ levels in every case except the O^{16} ground state. It is pointed out that these 2^+ levels may arise from the same configuration as the lower-lying 0^+ states which are considered to be deformed. The degree of deformation is estimated from the $0^+ - 2^+$ energy separation and found to correspond to quite high deformation in some cases. The 6.06 MeV, 0^+, pair emitting state in O^{16}, which is considered to be "hole configuration" by Christy and Fowler, may be deformed and is suspected to have a shape like a line of four alpha-particles. Also, a rotation-like series of levels with spins and parities, 0^+, 1^-, 2^+, 3^- and 4^+ among the highly excited states of Mg^{24} which appears to correspond to a series expected for a linear rotator with six alpha-particles in a line is discussed. With Ne^{20}, indications of medium-deformed states are found. Analogous discussions on the levels in Be^8 and C^{12} are tried although the experimental evidence is less conclusive. A.

539.152.1

3090. ISOTOPIC SPIN IMPURITY. II. SHELL MODEL. W.M.MacDonald.
Phys. Rev., Vol. 101, No. 1, 271-9 (Jan. 1, 1956).

For Pt I, see Abstr. 550 (1956). The isotopic spin impurity introduced into nuclear states by the Coulomb interaction is calculated with jj-coupling shell-model wave functions. Upper limits on the impurity present in N + Z nuclei for $4 \leq A \leq 16$ are given and shown to be in agreement with the experimental work of Wilkinson on the isotopic spin selection rule for E1 transitions. A.

539.152.1

3091. LOW-LYING LEVEL STRUCTURE OF THE Zn^{65} NUCLEUS. J.B.Marion and R.A.Chapman.
Phys. Rev., Vol. 101, No. 1, 283-5 (Jan. 1, 1956).

Sulphur and beryllium samples have been used as energy-selective neutron absorbers to investigate the low-lying level structure of the Zn^{65} nucleus. The transmission through the samples of the neutrons from the $Cu^{65}(p, n)Zn^{65}$ reaction was measured as a function of the proton energy and the known resonances in the neutron total cross-sections of S and Be were observed for both the neutron group leaving Zn^{65} in the ground state and for a group leaving Zn^{65} in an excited state at 118 ± 8 keV. At a proton energy of 2.9 MeV, these two groups are of approximately the same intensity. The Q-value for the $Cu^{65}(p, n)Zn^{65}$ reaction was found to be -2.141 ± 0.005 MeV. The 585 keV resonance in S was observed with neutrons from the $V^{51}(p, n)Cr^{51}$ reaction and the threshold energy of 1.566 MeV for this reaction was confirmed. A.

539.152.1

3092. EFFECT OF HARD CORE ON THE BINDING ENERGIES H^3 AND He^3. T.Kikuta, M.Yamada and M.Morita.
Phys. Rev., Vol. 101, No. 1, 509-10 (Jan. 1, 1956).

A rough calculation suggests that a hard core potential reduces the binding energy of H^3 and pushes the wave-function out. The Coulomb energy is thus decreased relative to the calculation with Yukawa potentials (Abstr. 1029/1953), and may reduce to the experimental value. P.T.Matthews

539.152.1

3093. APPLICATION OF THE BACHER AND GOUDSMIT METHOD TO NUCLEAR SPECTRA. S.Meshkov and C.W.Ufford.
Phys. Rev., Vol. 101, No. 2, 734-9 (Jan. 15, 1956).

A method for the calculation of nuclear l^n matrix elements in terms of those of l^{n-1} is developed, assuming two-particle interactions. An example is the calculation of p^3 matrix elements as linear combinations of p^2 matrix elements. The coefficients in these linear combinations are tabulated. Application is made by calculating ${}_3Li^7$ energies from ${}_3Li^6$ energy data. A comparison of the calculated energies of ${}_3Li^7$ with experiment leads to some restrictions on the nuclear potential. To perform the calculation it is necessary to fit the ${}_3Li^6$ data; the results of the fit are presented. The existence of a $J = 5/2^-$ energy level in ${}_3Li^7$ at or near 6.53 MeV is also discussed. A.

539.152.1

3094. RADIATION WIDTHS OF NUCLEAR ENERGY LEVELS. J.S.Levin and D.J.Hughes.
Phys. Rev., Vol. 101, No. 4, 1328-41 (Feb. 15, 1956).

The highly excited energy levels formed by capture of slow neutrons can be studied by means of the resonances in neutron cross-sections as functions of energy. In this work the radiation widths of levels in heavy nuclei have been measured by means of total cross-section curves obtained with the Brookhaven fast chopper. The "shape", "area", and "interference" methods of analysing the neutron transmission data are described. The radiation widths obtained, together with results of similar measurements, show that radiation widths of levels in the same nuclide are nearly constant, the observed variations from level to level being of the order of the experimental error. The radiation widths decrease slowly with atomic weight, except for discontinuities at nuclear shells; these discontinuities can be satisfactorily correlated with variations in excitation energy and level spacing at the shells. The variation of radiation width with excitation energy and level spacing is consistent with theoretical calculations for electric dipole transitions; the absolute theoretical widths are too large by an order of magnitude, however. A.

539.152.1

3095. PERTURBATION PROCEDURE FOR BOUND STATES OF NUCLEI. M.Bolsterli and E.Feenberg.
Phys. Rev., Vol. 101, No. 4, 1349-57 (Feb. 15, 1956).

The model of nucleons moving in a fixed harmonic oscillator well provides a convenient starting point for calculations on the structure of light nuclei. One complication, the non-diagonal energy operator associated with the motion of the centre of mass, can be eliminated simply by adding the harmonic potential operator of the centre-of-mass motion to the correct Hamiltonian operator of the system. Following the construction of the correct zeroth-order linear combinations (in case of degeneracy) and the evaluation of the first-order energy matrix, the further development of the theory, in the direction of an exhaustive investigation of the consequences of assumed interaction operators, requires the evaluation of second- and higher order contributions to the energy. A simple, accurate, and powerful procedure for evaluating the second-order energy and other second-order quantities in closed form is described and explicit formulae are given for the application to the ground states of the deuteron, the triton, and the alpha-particle. Numerical results for the deuteron, where a comparison with exact calculations is possible, are surprisingly good. The extension of these calculations to the

irst p-shell and beyond with the aid of the technique of fract-onal parentage coefficients appears feasible. A.

539.152.1

096. COUPLING OF NUCLEON ORBITALS. P.Gold-ammer.
Phys. Rev., Vol. 101, No. 4, 1375-80 (Feb. 15, 1956).

The coupling of nucleon orbitals through the mediation of urface waves is treated by the intermediate coupling proce-ure, considering only states with 0, 1 and 2 surfons. A single-ucleon description appropriate for $_{14}Si_{15}$ and $_{15}P_{14}$, and a three-ucleon description with T = 3/2 appropriate for $_{14}Si_{17}$ and $_{17}Cl_{20}$ (3 proton holes) are considered. $2s_{1/2}$ and $1d_{3/2}$ orbitals re coupled in this mass region. $(2s_{1/2})^2(1d_{3/2})$, $(2s_{1/2})(1d_{3/2})^2$, nd $(1d_{3/2})^3$ states are coupled in the three-nucleon systems. M1 transition matrix elements between I = 3/2+ and I = 1/2+ tates are small but not l-forbidden as they are for pure $d_{5/2} \rightarrow 2s_{1/2}$ transitions. The l-forbidden 1/2+ → 3/2+Gamow-Teller matrix element in the decay $_{15}P_{14} \rightarrow {}_{14}Si_{15}$ has the value .027 (experimental value 0.040). The correction to the $\mu_{1/2}$ chmidt moment in $_{14}Si_{15}$ is about one-half the experimental eviation; while the correction to the $\mu_{3/2}$ moment for $_{17}Cl_{20}$ is .788, compared to 0.552 observed. Similar calculations for hree-nucleon systems with T = 1/2 yield results applicable to $_{15}P_{16}$ and $_{18}A_{19}$. The coupling of $1g_{7/2}$, $2d_{5/2}$, $2d_{3/2}$ and $3s_{1/2}$ roton orbitals in $_{51}Sb_{70}$ and $_{51}Sb_{72}$ is treated by a single-nucleon escription. The electric quadrupole moments of both $_{51}Sb_{70}$ nd $_{51}Sb_{72}$ are accounted for and an appreciable M1 matrix lement is found for the "1-forbidden" transition 5/2+ → 7/2+ n $_{51}Sb_{72}$. A.

539.152.1

097. THE POSSIBILITY OF A PHASE CHANGE IN UCLEAR MATTER. L.E.H.Trainor and W.R.Dixon.
anad. J. Phys., Vol. 34, No. 3, 229-33 (March, 1956).

The possibility is discussed that Livesey's hypothesis of constant nuclear temperature at low excitations is indicative f a phase change in nuclear matter. A.

539.152.1 : 530.145

098. ON THE VARIATION OF BINDING ENERGY OF THE AST NUCLEON AND THE NUCLEAR EXCHANGE FORCES. .Ghosh and S.Sengupta.
ndian J. theor. Phys., Vol. 3, No. 1, 27-34 (March, 1955).

It is shown in the following that the assumptions made egarding B_{NN} etc. by Sengupta (1953) in an earlier paper are erivable from a mixture of Wigner and Majorana forces. Comparison with experimental values of B_{NN} etc. are also nade. A new characteristic is revealed in the variation of B_{NZ} (N, Z) with the parity of N + Z, which is interpreted as howing the existence of a spin-dependent term in the nuclear otential. A.

539.152.1 : 530.145

099. EFFECT OF THE TENSOR FORCE ON THE LEVEL TRUCTURE OF Li^6 AND Li^7. A.M.Feingold.
hys. Rev., Vol. 101, No. 1, 258-70 (Jan. 1, 1956).

The splittings of the $^3S_1$ and $^1S_0$ states of Li^6 and the P oublet states of Li^7 by the tensor force are calculated by a ariational method which includes the effect of configuration nteraction. Other forces which would contribute to the splitting, uch as spin-dependent central forces or vector spin-orbit orces, are not considered. The method of calculation is based n the use of a variational function of the form $\Psi = \Psi_0 + \lambda t' \Psi_0$, here t' is essentially the tensor force, treated as a perturba-on on a central force oscillator wave function, Ψ_0. The effect f the tensor force is shown to be equivalent to a mixture of rdinary and spin-exchange central forces plus a vector type pin-orbit force of rather complicated structure. Using a u-Massey Gaussian shape tensor potential, an S-state split-ng of 1.4 MeV is found for Li^6 and an inverted P-doublet split-ng of 380 keV is found for Li^7. A Yukawa shape potential ould give similar results. In view of the approximations made in the analysis, these results are in reasonable agreement with the experimental splittings of 3.5 MeV and 480 keV for Li^6 and Li^7 respectively. The tensor force is found to contribute about 12 MeV to the binding energy of these nuclei and to introduce a 6% admixture of excited states into the ground state. The im-portance of configuration interaction is shown by a second-order perturbation calculation neglecting configuration which gives entirely different results — a negligible S-state splitting for Li^6 and a normal P doublet structure for Li^7. The effect of the tensor force on the P-doublet separation in Be^7 and the F doublet separation in Li^7 is discussed briefly. A.

539.152.1 : 537.534.74

3100. THE OPTICAL MODEL APPLIED TO THE ELASTIC SCATTERING OF NUCLEONS BY VARIOUS LIGHT NUCLEI. E.J.Burge, Y.Fujimoto and A.Hossain.
Phil. Mag. (Ser. 8), Vol. 1, 19-33 (Jan., 1956).

The optical model of the nucleus has been applied to the elastic scattering of 9.5 MeV protons by He, C, N, O, F, Ne and A, and 14 MeV neutrons by C, N and O. In general, fair agreement has been obtained for a square-well potential, but the results suggest that for higher energies and heavier nuclei a shaping of the well is necessary. By making the nuclear radius a variable parameter, instead of $1.45 \times A^{1/3} \times 10^{-13}$ cm, better agreement could probably be obtained. The mean free path of nucleons of these energies in nuclear matter is found to be larger than the nuclear radius. No simple relation was found between the depth of the potential-well and the atomic weight. A.

539.152.1

3101. PARAMAGNETIC RESONANCE HYPERFINE STRUC-TURE OF Co^{60}. W.Dobrowolski, R.V.Jones and C.D.Jeffries.
Phys. Rev., Vol. 101, No. 3,1001-5 (Feb. 1, 1956).

The microwave paramagnetic resonance hyperfine struc-ture of Co^{60} has been observed in a magnetically dilute single crystal of cobalt ammonium sulphate at 20°K. From the num-ber of h.f.s. components and from their spacing relative to those of Co^{59}, the spin $I(Co^{60}) = 5$ and the magnetic moment $|\mu(Co^{60})| = 3.800 \pm 0.007$ nm are directly determined. These results are discussed in relation to those of β, γ spectro-scopy, nuclear alignment experiments, and the nuclear shell model. A.

539.152.2

3102. ON THE DEVIATION OF MAGNETIC MOMENTS OF $S\frac{1}{2}$ NUCLEI FROM THE SCHMIDT LIMITS. M.L.Chaudhury.
Indian J. Phys., Vol. 29, No. 7, 319-28 (July, 1955).

The present attempt to explain the deviations of the magnetic moments of the $S\frac{1}{2}$-nuclei from the Schmidt limits, is based on the assumption that this deviation is essentially due to the change in the intrinsic magnetic moment of the last odd particle as a result of exchange of vector mesons between it and the adjacent nucleons of the core. The exchange moment has been calculated by the usual perturbation method. The agreement with experimental findings is discussed. A.

539.152.2

3103. THE QUADRUPOLE MOMENTS OF ODD A NUCLEI. M.A.Perks.
Proc. Phys. Soc. A, Vol. 68, Pt 11, 1083-5 (Nov., 1955).

It was found that it is not possible to explain the large quadrupole moments in the region $100 < A < 200$ on the basis of simple interconfigurational mixing. J.Hughes

539.152.2

3104. NUCLEAR MAGNETIC DIPOLE AND ELECTRIC QUADRUPOLE ENERGY RELATIONS. L.C.Brown and P.M.Parker.
Phys. Rev., Vol. 100, No. 6, 1764-7 (Dec. 15, 1955).

Calculations based on existing theory of nuclear magnetic dipole and electric quadrupole transitions provide general expressions in closed form relating I, μH_0, e^2Qq, η, θ, and

ϕ to experimentally determined frequencies ν_{ij}. The angles θ and ϕ determine the orientation of H_0 in the principal axis system of ∇E. Methods of applying the expressions in specific situations are discussed. Application of the procedure to similar systems, such as the asymmetric rotator, is pointed out. A.

539.152.2

3105. ALIGNMENT OF THREE ODD-A RARE-EARTH NUCLEI. E.Ambler, R.P.Hudson and G.M.Temmer.
Phys. Rev., Vol. 101, No. 1, 196-200 (Jan. 1, 1956).

The results of nuclear magnetic h.f.s. alignment experiments on Ce^{139} are presented, and are discussed in relation to those previously obtained for Ce^{141} and Nd^{147} (Abstr. 3973/1955). It is shown that the gamma-ray anisotropies, ϵ, in the case of Ce^{139} are consistent with a decay sequence $3/2^+ \rightarrow 5/2^+ \rightarrow 7/2^+$, the gamma transition being M1 with about 4% admixture of E2. Even such a small admixture of E2 has an important effect upon the anisotropy through the interference term. Other factors which might affect the anisotropy are discussed: electron spin–spin interactions are important, whereas reorientation effects due to long lifetimes in the intermediate state are not. Interference is also important in the case of the 92 keV gamma ray following the decay of Nd^{147}, where about 3% admixture of E2 radiation is needed to explain the results. It seems likely also that there is a similar effect in the 142 keV gamma ray following the decay of Ce^{141}. The similarity of these mixtures (same magnitude and phase $\phi = 0$) may not be fortuitous, since in each case the gamma ray connects levels which are classified by the shell model as $d_{5/2}$ and $g_{7/2}$. In the cases of Ce^{141} and Nd^{147} the $g_{7/2}$ state lies uppermost and ϵ is reduced by the E2 admixture, whereas ϵ is increased in Ce^{139}, where the levels are inverted. A.

539.152.2

3106. BACK-GOUDSMIT EFFECT IN HFS OF Na^{23} $3\,P_{3/2}$ AND THE ELECTRIC QUADRUPOLE INTERACTION COEFFICIENT. G.S.Bogle, J.N.Dodd and K.H.Purser.
Phys. Rev., Vol. 101, No. 1, 246 (Jan. 1, 1956).

Recent r.f. resonance experiments, at zero magnetic field, on the h.f.s. of Na^{23} $3\,P_{3/2}$ left some doubt as to whether the value of the electric quadrupole coefficient, b, was 2.6 or – 21.6 Mc/s. It is pointed out that the doubt can be resolved by experiments under Back-Goldsmit coupling conditions, since a resonance curve showing four or three main maxima will be observed, respectively, according as b = 2.6 or – 21.6 Mc/s. Under these conditions, too, the Landé factor can be measured. Preliminary experiments are reported which give a value of 1.34 ± 0.02 for the Landé factor. A.

539.152.2

3107. THEORY OF RELAXATION BY SEMI-ROTATIONS IN QUADRUPOLE RESONANCE. J.Seiden.
C.R. Acad. Sci. (Paris), Vol. 242, No. 6, 763-6 (Feb. 6, 1956). In French.

539.152.2 : 531.383

3108. VISIBLE MODEL FOR NUCLEAR RESONANCE. H.Dänzer.
Z. Phys., Vol. 144, No. 1-3, 226-36 (1956). In German.

Reviews Bloch's nuclear resonance equations and describes a spinning top analogue model which demonstrates transverse and longitudinal relaxation times. D.H.Whiffen

539.152.2 : 535.338.332

ON THE FINE AND HYPERFINE STRUCTURE OF THE Rb II SPECTRUM AND THE NUCLEAR QUADRUPOLE MOMENT OF Rb^{87}. See Abstr. 1968

539.152.2 : 539.166

3109. AN ATTEMPT TO DETECT THE ELECTRIC 16-POLE MOMENT OF Cd^{111}. E.Heer and R.Rüetschi.
Helv. phys. Acta, Vol. 28, No. 5-6, 525-8 (1955). In German.

An attempt has been made to find an interaction between the electric field of a cubic crystal and the el. 16-pole moment of the Cd^{111} nucleus (247 keV level) by means of angular correlation methods. No remarkable effect has been observed. Experimental results and a rough theoretical estimation of the interaction energy are compared. A.

539.153

3110. K-SHELL IONIZATION OF VARIOUS ELEMENTS BY ALPHA-PARTICLES. R.R.Roy, A.Lagasse, M.L.Goes and J.Diltoer.
C.R. Acad. Sci. (Paris), Vol. 241, No. 24, 1749-51 (Dec. 14, 1955). In French.

This was measured for Cu for $1 \lesssim E\alpha \lesssim 4$ MeV and for Fe, Ni, Cu, Zn, Se, Mo and Ag at $E\alpha = 3.4$ MeV. The results are compared with theory (Henneberg, Z. Phys., Vol. 86, 592, 1933). A.O.Stanesby

539.153

3111. ANALYSIS OF THE FIRST SHORT PERIOD AND ITS ISOELECTRONIC SEQUENCES. F.Rohrlich.
Phys. Rev., Vol. 101, No. 1, 69-79 (Jan. 1, 1956).

The configurations $2p^n$, $2s2p^{n-1}$ and $2s^22p^{n-2}$ are analysed for all observed spectra of the respective isoelectronic sequences. The semiempirical Slater method is amended to include the polarization correction and, wherever possible, configuration interaction. The polarization parameter Λ is found to be approximately linear in the degree of ionization, q. The Slater parameters characteristic of the term separations of $2s^m2p^n$ and of configuration interaction are found to be linear functions of m, n and q, partly corresponding to the Bacher–Goudsmit theory in second approximation. A comparison with self-consistent field calculations is made. Other consequences of the analysis are discussed. A.

539.153

3112. HFS SEPARATIONS AND HFS ANOMALIES IN THE $^2P_{1/2}$ STATE OF Ga^{69}, Ga^{71}, Tl^{203} AND Tl^{205}. A.Lurio and A G.Prodell.
Phys. Rev., Vol. 101, No. 1, 79-83 (Jan. 1, 1956).

By use of the method of atomic beam magnetic resonance, the ground state hyperfine structure splittings in the two common gallium and thallium isotopes have been measured. The measured values are; $\Delta\nu(Ga^{69}) = (2677.9875 \pm 0.0010) \times 10^6$ sec^{-1}, $\Delta\nu(Ga^{71}) = (3402.6946 \pm 0.0013) \times 10^6$ sec^{-1} $\Delta\nu(Tl^{203}) = (21\,105.447 \pm 0.005) \times 10^6$ sec^{-1} and $\Delta\nu(Tl^{205}) = (21\,310.835 \pm 0.005) \times 10^6$ sec^{-1}. A comparison of the ratio of the dipole coupling constants in the ground state of the two isotopes with the ratio of the nuclear g_I factors yields the h.f.s. anomaly. Theoretical and experimental values of the anomaly are compared. A.

539.153

3113. STRUCTURE OF Ta I. T.A.M.van Kleef and P.F.A.Klinkenberg.
Phys. Rev., Vol. 101, No. 1, 489 (Jan. 1, 1956).

Kamai stated (Abstr. 9010/1955) that an error was made in modifying the energy matrix given by Marvin and that the table of the composition of the states of Ta I $5d^36s^2$ given by van den Berg, Klinkenberg and van den Bosch (Abstr. 5655/1952) was therefore incorrect. It is pointed out that a substitution error which was indeed made has only a very slight effect on the final table. The deviations are insignificant compared to the uncertainties introduced by the neglect of the configuration interaction d^3s^2 - d^4s and by the arbitrary manner by which the configuration parameters are derived. D.J.Prowse

539.153

3114. HYPERFINE STRUCTURE OF THE METASTABLE HYDROGEN ATOM. J.W.Heberle, H.A.Reich and P.Kusch.
Phys. Rev., Vol. 101, No. 2, 612-20 (Jan. 15, 1956).

The hyperfine separation $\Delta\nu(2S)$ of the metastable

$^2S_{1/2}$ state has been measured by a new atomic-beam magnetic-resonance method. R.f. transitions were detected by utilizing a property peculiar to metastable hydrogen atoms, namely, that atoms with $m_J = -\frac{1}{2}$ decay much more rapidly in passing through a magnetic field of about 575 gauss than do atoms with $m_J = +\frac{1}{2}$. It was found that $\Delta\nu(2S) = 177\,556.86 \pm 0.05$ kc/s. From this result and the very accurately known hyperfine separation $\Delta\nu(1S)$ of the ground state, a value is obtained $R \equiv \Delta\nu(2S)/\Delta\nu(1S) = \frac{1}{8}(1.000\,034\,6 \pm 0.000\,000\,3)$. The deviation of R from the available theoretical value suggests the existence of a higher-order quantum-electrodynamic term. A method of velocity selection by electron impact is described. A.

539.153

3115. THEORY OF MULTIPLE-QUANTUM TRANSITIONS IN THE GROUND STATE OF K^{39}. H.Salwen.
Phys. Rev., Vol. 101, No. 2, 623-6 (Jan. 15, 1956).

The results of an earlier paper are applied to magnetic resonance transitions in the ground state of K^{39}. Formulae are obtained for the parameters characterizing single- and multiple-quantum transitions, and the values of these parameters are calculated for a Zeeman field corresponding to $x = 0.21135$. A.

539.153

3116. FURTHER OBSERVATIONS OF MULTIPLE-QUANTUM TRANSITIONS. SATURATION EFFECTS IN RADIO-FREQUENCY TRANSITIONS. P.Kusch.
Phys. Rev., Vol. 101, No. 2, 627-36 (Jan. 15, 1956).

Multiple-quantum as well as the single-quantum transitions, $\Delta F = 0$, $\Delta m = \pm 1, 2, 3, 4$, have been observed in K^{39}. In the neighbourhood of the r.f. amplitude, required to give a maximum transition probability, the lines have the behaviour predicted for transitions induced by a rectangular r.f. pulse. For higher r.f. amplitudes, the line width becomes constant or else decreases after having reached a maximum width, the line frequency is modified less rapidly than predicted and anomalous transition probabilities occur. All these effects are markedly dependent on the details of construction of the r.f. circuit in which transitions are induced. It is suggested that these effects may arise from the end regions of the circuit through an adiabatic traverse of the circuit by the atom. A.

539.153

3117. THE STRUCTURES OF THE GROUND MULTIPLETS OF CERTAIN RARE-EARTH IONS. B.R.Judd.
Proc. Phys. Soc. A, Vol. 69, Pt 2, 157-64 (Feb., 1956).

Departures from the Landé interval rule in the ground multiplets of certain rare-earth ions are examined. It is found that magnetic spin-spin interactions between the 4f electrons are much too small to account for the apparent distortions, but that by allowing for the partial breakdown of Russell-Saunders coupling it is possible to obtain satisfactory agreement between experiment and theory. Values of the spin-orbit constant ζ are given for several rare-earth ions, and the positions of a number of excited multiplets are tabulated. A.

539.153

3118. SPINS AND HYPERFINE STRUCTURE SEPARATIONS OF RADIOACTIVE Au^{198} AND Au^{199}. R.L.Christensen, J.R.Hamilton, A.Lemonick, F.M.Pipkin, J.B.Reynolds and W.H.Stroke.
Phys. Rev., Vol. 101, No. 4, 1389-95 (Feb. 15, 1956).

The focusing atomic beam apparatus has been used to measure the spins and hyperfine structure separations of Au^{198} (2.7 days) and Au^{199} (3.15 days). The observed spins are 2 for Au^{198} and $\frac{3}{2}$ for Au^{199}. Observed $\Delta\nu$ for Au^{198} is $21\,800 \pm 150$ Mc/s, assuming μ_I to be positive, or $22\,500 \pm 150$ Mc/s, assuming μ_I to be negative. $\Delta\nu$ for Au^{199} is $11\,110 \pm 130$ Mc/s, assuming μ_I to be positive, or $11\,180 \pm 130$ Mc/s, assuming μ_I to be negative. The high $\Delta\nu$ for Au^{198} made it necessary to study that element by observation of multiple-quantum transitions. A.

539.153 : 523.752 : 523.775

3119. THE HIGH TEMPERATURE EXCITATION OF HELIUM. J.T.Jefferies.
Austral. J. Phys., Vol. 8, No. 3, 335-46 (Sept., 1955).

The relative population of the helium ground state, the singlet and triplet states of principal quantum number 2 and 3, and the ionized state are obtained for an atmosphere isothermal at one of a number of kinetic temperatures in the range 10^4-$10^{5.0}$K. It is shown that the non-appearance of the D_3 line of helium in the solar Fraunhofer spectrum may be reconciled with the simultaneous appearance of the infrared λ 10830 line, provided the mean kinetic temperature of the chromosphere is not too great. From an analysis of observations of the D_3 emission of the solar chromosphere, it is concluded that the mean kinetic temperature of the lower chromosphere is most probably in the range 10^4-$1.25 \times 10^{4.0}$K. A.

539.153 : 530.162

3120. STATISTICAL APPROACH TO COLLISION PROCESSES: APPLICATION TO ATOMIC EXCITATION. R.W.Hart, E.P.Gray and W.H.Guier.
Phys. Rev., Vol. 101, No. 1, 84-92 (Jan. 1, 1956).

A statistical description is developed for collision phenomena such as atomic excitation, where it is important to recognize that the motion of the bound and free particles is ordered, rather than chaotic. This is accomplished by using the concept of a collision complex which is permitted to decay only into final states of ordered motion in which conservation of the initial energy and angular momentum would allow the system to be found long after collision. A major feature of this approach is that, while it deals with ordered motion exclusively, the interparticle interaction does not appear explicitly, but is implied by the usual assumption in statistical mechanics that it is the mechanism for establishing a uniform distribution in the accessible phase space. The theory is applied in a semiclassical form to the single excitation of atoms by electron impact. Cross-sections for H and He are compared with the Born approximation and for He with experimental data. A.

539.153.4

3121. GROUND STATES OF HYDROGENIC ATOMS. R.O.A.Robinson.
Amer. J. Phys., Vol. 24, No. 1, 44-5 (Jan., 1956).

The binding energy and wave function can be obtained by a variational calculation. G.E.Brown

539.153.4

3122. CALCULATION OF THE GROUND STATE OF A 3-ELECTRON ATOM BY THE PERTURBATION METHOD. P.Kessler.
C.R. Acad. Sci. (Paris), Vol. 242, No. 3, 350-2 (Jan. 16, 1956). In French.

The author's method (Abstr. 5225/1955) is applied to the $1s^22s$ state of a 3-electron atom. For the atoms Li, Be^+, B^{++}, C^{+++}, the numerical results are in good agreement with the observed values. J.Hughes

539.153.4

3123. CALCULATION OF THE GROUND STATE OF AN ATOM WITH FOUR ELECTRONS BY THE PERTURBATION METHOD P.Kessler.
C.R. Acad. Sci. (Paris), Vol. 242, No. 6, 742-4 (Feb. 6, 1956). In French.

The inter-electron Coulomb interaction is taken as the perturbation. The main second order terms are included, and good values for the energy are obtained. G.E.Brown

539.153.4

3124. QUANTUM-ELECTRODYNAMICAL FOURTH-ORDER CORRECTIONS FOR TRIPLET FINE STRUCTURE OF HELIUM. G.Araki.
Phys. Rev., Vol. 101, No. 4, 1410-11 (Feb. 15, 1956).

The quantum-electrodynamical fourth-order corrections for the intervals of the triplet fine structure of helium are calculated by taking into account the one-electron Lamb-shift for the self spin-orbit coupling and the effect of the anomalous magnetic moment on the mutual spin-orbit and spin-spin coupling between two electrons. The values of the radial integrals are taken from the author's previous calculation. The calculated values of the corrections are within the range of experimental errors in the case of optical measurements but they amount to observable quantities in a microwave experiment. A.

539.155.1 : 537.534.3

3125. EXPLANATION OF DISCREPANCIES IN THE MASS-SPECTROGRAPHIC DOUBLET MEASUREMENTS. F.Everling and J.Mattauch.
Z. Naturforsch., Vol. 11a, No. 1, 68-71 (1956). In German.

Measurement series were carried out for the doublets (CH_2—N) and (NH_3—OH) and the triplet (CH_4—NH_2—O), and the mass differences were evaluated by means of three dispersion lines in each case. A systematic variation of the mass difference of the doublet with the magnetic field intensity applied was discovered for each series. The discrepancies amount to only a fraction of the line width; they are attributed to causes mentioned by Ewald (Abstr. 243/1949). The systematic variation has the highest value for the doublet (CH_4—O). The systematic error involved is probably responsible for discrepancies between data found for the measured doublets by different authors. A method is suggested for obviating this error. F.Lachman

539.155.2

3126. SEPARATION OF SOME ISOTOPES BY CONVECTION DIFFUSION. D.Heymann and J.Kistemaker.
J. chem. Phys., Vol. 24, No. 1, 165-6 (Jan., 1956).

The separation of the isotopes of Ne, A, O_2, N_2 and H_2-D_2 was achieved in a column in which a stream of water or methanol vapour flowed from a heated inner tube of porous porcelain (2.0 cm dia. and 90 cm long) across an annular gap (0.7 cm wide) to a water cooled Pyrex tube. The primary separation of the isotopic mixture contained in this annulus was by horizontal ("sweep") diffusion in the water or methanol vapour stream, and the multiplication obtained by a counter-current enrichment process. The overall separation factors obtained were 1.52 ± 0.02 for Ne(20/22) using water, and 1.17 ± 0.01 for A(36/40) using methanol. The height of the equivalent theoretical plate in these two cases is calculated to be 2-3 cm and 6-7 cm respectively. The results of 21 experiments are reported. H.C.Cole

539.155.2

3127. PREPARATION OF THE RARE ISOTOPE Ne^{21}. P.A.K.Clusius, M.Huber, H.Hürzeler and E.Schumacher.
J. chem. Phys., Vol. 24, No. 1, 167-8 (Jan., 1956).

This was achieved in a thermal diffusion column 23 m in length, by stripping off the Ne^{20} and Ne^{22}. A mixture of deuterated methanes was used as an auxiliary gas to obtain the final separation and concentration of the Ne^{21}. Starting with 60 litres of commercial neon containing 0.25% Ne^{21} about 20 cm^3 of neon enriched in Ne^{21} to more than 95% was obtained. The purest fraction contained 99.6% Ne^{21} with 0.2% Ne^{20} and 0.2% Ne^{22}. The method is being studied for the separation of of the rare A^{38} from A^{36} and A^{40} by using DCl as an auxiliary gas. A preliminary experiment gave samples of 90% A^{38} compared with the initial value of 0.063% A^{38}. H.C.Cole

539.155.2 : 530.162

3128. STATISTICAL MECHANICS OF MIXTURES OF ISOTOPES. G.V.Chester.
Phys. Rev., Vol. 100, No. 2, 446-54 (Oct. 15, 1955).

The excess free energy of a mixture of isotopes is expanded in a Taylor series in powers of the relative mass differences $(m_0 - m_j)/m_j$, where m_j and m_0 are the masses of the particles of the jth component and of a reference isotope, respectively. This expansion is only useful if it assumed that all the particles in the mixture obey classical or Boltzmann statistics When this assumption is made it is found that the linear term in the expansion vanishes identically. The second-order term has the form $\sum_i^S \sum_j^S x_i x_j (\lambda_i - \lambda_j)^2 . Q$, where Q is a universal function of m_0, T, and V, λ_j equals $(m_0 - m_j)$ m_j and x_j is the mole fraction of the jth component. This expression gives the explicit dependence of the excess free energy on the mole fractions and on the relative mass differences λ_j. From this result it can be shown, among other things, that a phase separation of the isotopes in a mixture should take place at a sufficiently low temperature. It can also be shown that there is an approximate law of corresponding states between different mixtures of isotopes. The theory is directly applicable to all solid mixtures and to fluid mixtures of the hydrogen isotopes. Unfortunately owing to the lack of experimental data it is impossible to test the theory rigorously. Finally it is shown how the theory can be used to interpret the behaviour of He^3—He^4 solutions. When sufficient experimental data becomes available the theory should throw considerable light on the influence of quantum statistics on the properties of these solutions. A.

539.155.2 : 537.363

3129. THE ISOTOPIC EFFECT OF THE PASSAGE OF CURRENT IN MOLTEN POTASSIUM METAL. A.Lundén, C.Reuterswärd and A.Lodding.
Z.Naturforsch., Vol. 10a, No. 12, 924-6 (1955). In German.

The passage of a direct current at a current density of 2900 amp/cm^2, for a period of 14.8 days through molten potassium produced a partial separation of the potassium isotopes. The molten metal was contained in a capillary tube 0.6 mm internal diameter and 40 cm long. K^{41} was enriched at the cathode and K^{39} at the anode. The separation factor between the anode and the cathode was 1.12, and the value of the "mass-effect" constant (Abstr. 1272/1947) was 9×10^{-6} or greater. H.C.Cole

539.155.2 : 537.534.72

PRODUCTION AND UTILIZATION OF ELECTROMAGNETICALLY ENRICHED ISOTOPES. See Abstr. 2191

539.155.4

3130. MASSES OF NUCLEI WITH $Z \geq 40$. G.Bussetti.
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1301-7 (Dec., 1955) In Italian.

Masses calculated by the semiempirical formula of the drop model are given. Two coefficients of the formula have been recalculated with the method of least squares. A.

539.156

3131. THE EXACT CALCULATION OF LONG-RANGE FORCES BETWEEN ATOMS BY PERTURBATION THEORY. A.Dalgarno and J.T.Lewis.
Proc. Roy. Soc. A, Vol. 233, 70-4 (Dec. 6, 1955).

A general sum rule is described which has many variants; it permits, for example, the exact calculation of the long-range forces between a proton and a hydrogen atom using conventional perturbation theory. The method is exemplified by the calculation of the second-order term and a precise assessment of the significance of the continuum states is made. The basic identity for a given function g is $(r|g|s)/(E_r - E_s) = (r|f|s)$ where the function f satisfies a certain differential equation. The limitation of the method is the difficulty which may arise in solving the equation. The sum rule technique appears to have applications to many fields. A.

RADIOACTIVITY. α-, β- AND γ-RAYS 539.16

539.163

3132. RADIOACTIVE ^{186}TANTALUM. A.J.Pol.

Phil. Mag., Vol. 46, 1165-8 (Nov., 1955).

The new radioactive isotope Ta^{186} has been prepared and its decay characteristics determined as follows: half-life, 10.5 ± 0.5 min; maximum β-energy, 2.2_2 MeV; conversion-electron energies, 0.15 MeV or less; γ-ray energies, 125, 200, 300, 410, 510, 610, 730, 940 and possibly about 1150 keV. The mass assignment suggested by its production by (n, p), but not by (γ, p), reactions on tungsten was confirmed by experiments using tungstic acid enriched in W^{186}. A.

539.163

3133. PROPERTIES OF Em^{221}. F.F.Momyer, Jr and E.K.Hyde.

Phys. Rev., Vol. 101, No. 1, 136-8 (Jan. 1, 1956).

A new isotope of the element emanation has been identified among the spallation products of thorium bombarded with 340 MeV protons. This isotope, Em^{221}, decays with a half-life of 25 min. The decay goes 80% by beta emission to Fr^{221} identified by its characteristic alpha-particle groups and by the observance of the alpha-particles of the decay products, At^{217} and Po^{213}. In 20% of its disintegrations Em^{221} emits an alpha-particle of 6.0 MeV energy unresolved from the 6.0 MeV alpha-particle of Fr^{221}, and gives rise to Po^{217}, a previously unreported isotope of polonium. Po^{217} has a half-life of less than 10 sec and emits alpha-particles of 6.54 ± 0.02 MeV. An attempt was made to isolate Em^{221} from a sample of Th^{229} where it should be found as a result of slight alpha branching of Ra^{225}. The experiment was negative and a lower limit of 500 years was placed on the partial alpha half-life of Ra^{225}. A.

539.163

3134. ft VALUES AND L/K RATIOS FOR ORBITAL ELECTRON CAPTURE. R.W.Hoff and J.O.Rasmussen.

Phys. Rev., Vol. 101, No. 1, 280-2 (Jan. 1, 1956).

The calculation of ft values for allowed and first forbidden orbital electron capture transitions is discussed. It is shown that ft values for $\Delta I = 1$, yes, orbital electron capture transitions, calculated using allowed f functions, can be compared directly with ft values for similar transitions involving beta particle emission. The L/K electron capture ratios for $\Delta I = 1$, yes, transitions are shown generally to be the same as for allowed transitions of similar energy for a given element. Comparison with experimentally measured L/K capture ratios is made. A.

539.163.1

3135. MEASUREMENT OF THE MEAN LIFE OF THE SECOND EXCITED STATE OF FLUORINE 19. M.Fiehrer, P.Lehmann, A.Lévêque and R.Pick.

C.R. Acad. Sci. (Paris), Vol. 241, No. 24, 1746-8 (Dec. 14, 1955). In French.

The mean life was found by the delayed coincidence technique: $(1.23 \pm 0.07) \times 10^{-7}$ sec [½-life = (8.5 ± 0.5) x 10^{-8} sec]. A.O.Stanesby

539.163.2

3136. THE NUMBER OF γ-QUANTA FROM POTASSIUM. G.Backenstoss and K.Goebel.

Z. Naturforsch., Vol. 10a, No. 12, 920-4 (1955). In German.

A new absolute determination by comparison with the γ-radiation of Pr^{142} gave 3.50 ± 0.14 γ-quanta g^{-1}. sec^{-1} for naturally occurring K; the number of β-particles emitted is 28.0 g^{-1}. sec^{-1}, so that the branching ratio is 0.125. A.O.Stanesby

539.163.2

3137. THE DECAY SCHEME OF URANIUM 235. S.A.E.Johansson.

Ark. Fys., Vol. 10, Paper 9, 97-108 (1955).

The gamma-radiation from enriched U^{235} has been investigated by means of a coincidence scintillation spectrometer. Gamma-rays were found at 74, 110, 184, 200, 289 and 382 keV. The coincidence relations between the gamma-rays were investigated in detail. These measurements lead to a decay scheme which is in good agreement with the alpha-ray spectrum. The possibility of interpreting the level scheme as a system of rotational bands is discussed. A.

539.163.2

3138. ON THE DECAY SCHEME OF $_{83}Bi^{214}$ (RaC). R.A.Ricci and G.Trivero.

Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 745-59 (Oct., 1955). In Italian.

Experiments have been continued on the spectrum of $_{83}Bi^{214}$, analysis of the absorption of the β-radiation and the determination of coincidences β-γ, with complete separation of the γ-rays from $^{214}_{84}Po$. The results are consistent with those of Wapstra and Latishev referring to the maximum energy of the β-transition in the fundamental state (3.17 MeV) (relative intensity 13%) and confirm the presence of a transition energy of 2.56 MeV at the first excited state of $_{84}Po^{214}$, already reported by the authors, of relative intensity about 6%. The spectrum analysis reveals moreover the presence of other β-transitions of energy respectively 1.720 MeV (relative intensity 7%), 1.44 MeV (30%) and 1.03 MeV (22%). Transitions of energy less than 1 MeV certainly exist and their relative intensity, following the present results, should be about 20%. From this a β-decay scheme may be deduced for $_{83}Bi^{214}$ which is in fairly good accord with the scheme of γ-levels of $_{84}Po^{214}$ recently proposed by Demichelis and Malvano. A.

539.163.2

3139. ON THE DECAY OF $^{51}_{24}Cr$. A.Bisi, E.Germagnoli and L.Zappa.

Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 1052-7 (Nov., 1955).

From the energy spectrum of γ-rays emitted in the decay $_{24}Cr^{51} \rightarrow {}_{23}V^{51}$ a revised scheme of the levels of $_{23}V^{51}$ is deduced. A direct determination of the energy involved in this transition is described. A.

539.163.2

3140. DISINTEGRATION OF SELENIUM-73. R.W.Hayward and D.D.Hoppes.

Phys. Rev., Vol. 101, No. 1, 93-7 (Jan. 1, 1956).

The radiations from the 7.1 hr Se^{73} activity have been investigated using magnetic lens, scintillation pulse-height and coincidence counting techniques. Two gamma-rays of 65.8 and 359 keV energy and of nearly equal intensity are observed to be in prompt coincidence with each other and in delayed coincidence with annihilation radiation resulting from the positron decay of the Se^{73} parent. Energy and intensity measurements indicate that a main group (E_{max} = 1.29 MeV, log ft = 5.3) excites the gamma-ray cascade, while a weaker group (E_{max} = 1.65 MeV, log ft ≤ 8.0) excites the 65.8 keV transition only. These data coupled with internal conversion information lead to a level scheme in As^{73} as follows: ground level, $p_{3/2}$; 65.8 keV level, $f_{5/2}$; and 425 keV level, $g_{9/2}$, $\tau_{\frac{1}{2}}$ = 6μsec. The 7.1 hr level in Se^{73} is in a $g_{9/2}$ state. A.

539.163.2

3141. DECAY SCHEME OF GALLIUM-72. J.J.Kraushaar, E.Brun and W.E.Meyerhof.

Phys. Rev., Vol. 101, No. 1, 139-47 (Jan. 1, 1956).

The decay of Ga^{72} has been investigated with scintillation spectrometers, both single and in coincidence. Evidence has been found for the existence of levels in Ge^{72} at 0.69, 0.84, 1.46, 1.73, 2.06, 2.39, 2.51, 2.82, 3.04, 3.32 and 3.34 MeV. The 0.3-μsec isomeric state has been definitely determined to be the first excited level at 0.69 MeV and, as previously indicated, requires a spin of 0 and even parity. Spins and parities of the other levels of Ge^{72} are discussed. A.

539.163.2

3142. DECAY OF RADIOACTIVE Ce^{143}(33.4 HR). D.W.Martin, M.K.Brice, J.M.Cork and S.B.Burson.

Phys. Rev., Vol. 101, No. 1, 182-8 (Jan. 1, 1956).

The beta and gamma radiations of Ce^{143} have been studied with a [illegible] with a Svedin-focusing magnetic spectrometer, and with [illegible]. Five beta-ray components and ten gamma rays are identified with the activity, and the decay scheme is established involving ten excited states of the daughter Pr^{143} nucleus. It is found that no beta rays of measureable intensity proceed directly to the Pr^{143} ground state. Spin and parity assignments are made for several of the levels. A.

539.163.2

3143. DECAY OF Co^{61} AND Cu^{61}. R.H.Nussbaum, A.H.Wapstra, W.A.Bruil, M.J.Sterk, G.J.Nijgh and N.Grobben. Phys. Rev., Vol. 101, No. 2, 905–6 (Jan. 15, 1956).

Beta and γ–scintillation spectrometers were used in coincidence to study radiations in the decay of these nuclides. β-decay (E_{max} = 1220 keV) in Co^{61} is followed by a single 70 keV γ–ray in Ni^{61}. β^+ and K–capture decay in Cu excite several γ–rays in Ni^{61} (70, 280, 380, 580, 660, 940, 1150 and 1220 keV). Their intensities were measured and a level scheme is proposed. M.A.Grace

539.163.2

3144. SHELL THEORY AND COLLECTIVE THEORY FOR THE Pt ISOTOPES. W.W.True.
Phys. Rev., Vol. 101, No. 4, 1342–9 (Feb. 15, 1956).

The 0.570 MeV gamma–ray in Pb^{207} and the 0.802 MeV gamma–ray in Pb^{205} are electric quadrupole transitions and have transition rates which are much too fast for neutron transitions. The surface tension parameters necessary to give the observed transition rates are determined by assuming that the collective motion of the core is weakly coupled to the external nucleons. The calculated surface tension parameters are [illegible] MeV for Pb^{207} and [illegible] MeV for Pb^{205}. These two values are large compared to the hydrodynamic surface tension, as expected near closed shells, but the difference of a factor of 2 is unexpected. The quadrupole moment of Bi^{209} also indicates weak surface coupling. Also determined are the configurations which describe the low–lying energy levels of Pb^{205}, assuming short–range two–body forces. Reasonable agreement with experiment indicates that the shell model can account for the main portion of the level splitting. Many levels are predicted which have not been observed as yet. The 0.375 MeV gamma–ray in Pb^{205} is anomalously slow even with weak surface coupling. A possible explanation for this situation is offered in the configurations describing the initial and final states in connection with the Pr^{141} problem. Formulas are given for angular correlation coefficients in the [illegible] coupling scheme for three and four particles. A.

539.163.2

3145. DISINTEGRATION OF Sc^{47}. W.E.Graves and S.K.Suri.
Phys. Rev., Vol. 101, No. 4, 1368–70 (Feb. 15, 1956).

The disintegration of Sc^{47} has been investigated with the help of magnetic spectrometers, scintillation spectrometers, and [illegible] counting. There are two beta–ray groups of end–point energies 0.600 ± 0.002 (40%) and 0.439 ±0.002 (60%, MeV, and one gamma–ray of 0.159 MeV. The gamma–ray is in coincidence with the lower energy group. A.

539.163.2

3146. DECAY OF Mg^{27}. W.S.Lyon and N.H.Lazar.
Phys. Rev., Vol. 101, No. 5, 1524–6 (March 1, 1956).

The gamma–rays accompanying the decay of 9.47 min Mg^{27} have been studied by use of a [illegible] spectrometer and beta–gamma coincidence counting. Three gamma–rays of energies 0.834, 1.015 and 0.175 MeV were found with relative intensities of 1.00, 0.43 and 0.009. The isotopic thermal–neutron activation cross–section for production of Mg^{27} is found to be 25 ± 2 millibarns. A.

539.163.2

3147. LONG–RANGE PARTICLES EMITTED BY A SOURCE OF PLUTONIUM 239. M.Adam.
J.de Phys. et Rad. (Paris), Vol. 16, No. 10, [illegible] (Oct., 1955). In French.

Long–range alpha (20–28μ) particles were detected in nuclear emulsions exposed to a source of Pu^{239}. They are possibly alpha–particles and may correspond to the long–range alpha–particles of Pu, Th and an unknown impurity, although they appear to have a continuous energy spectrum rather than a line structure. No relative abundances are given. A.G.Stanwood

539.163

3148. THE BETA–DECAY OF ^{230}Pa. Ong Ping Hok, P.Kramer, G.Meijer, J.W.R.Fennema and W.L.Zijp.
Physica, Vol. 21, No. 9, 719–27 (Sept., 1955).

The beta–decay of Pa^{230} was investigated with a magnetic beta–ray and a scintillator spectrometer. Thus led to 4 gamma–transitions from which two possible schemes of Th^{230} could be constructed. A beta–ray spectrum and a Fermi–plot with maximum energies of 0.4 MeV and 0.49 ± 0.02 MeV were also observed. These results, however, are not to be ascribed to decay of possible contaminations of fission products. A.

539.163

3149. UNIQUE FIRST FORBIDDEN BETA SPECTRUM OF ^{86}Br. A.Bisi, S.Terrani and L.Zappa.
Nuovo Cimento (Ser. 10), Vol. 1, No. 6, 1207–[illegible] (Dec., 1955).

The beta–ray spectrum of Br^{86} was investigated in an intermediate image beta–ray spectrometer. The transition energy was found to be: E_0 = 1.462 ± 0.005 MeV. The spectral shape from the end–point down to about 140 keV agrees with what is to be expected from a unique first–forbidden transition (ΔI = 2, yes). No branching at the 0.913 MeV isomeric level of Y^{89} ($\gamma/\beta < 5 \times 10^{-6}$), nor other gamma–rays were observed. A.

539.163

3150. SMALL–ORDER EFFECTS IN BETA SPECTRA. A.V.Ponm, R.C.Wannell and E.N.Jensen.
Phys. Rev., Vol. 101, No. 4, [illegible]–2 (Feb. 15, 1956).

An intermediate–image spectrometer and a flow–mica spectrometer were used to examine carefully the beta spectra of P^{32}, K^{42} and As^{76}. The P^{32} beta spectrum was found to have a first–order deviation and within the experimental error none was found. The value of the parameter r, describing the magnitude of the Fierz deviation as defined by Davidson and Peaslee was found to be 0.00 ± 0.03. The first forbidden transitions with ΔI = 0, "yes" of K^{42} and As^{76} were examined for deviations from a linear Kurie plot. Within experimental errors no deviations were found. From the shape factors calculated by Mahmoud and Konopinski on the basis of an STP [illegible], one would expect deviations for these first–forbidden transitions if the best previous estimate of various parameters are correct. A deviation of the K^{42} Kurie plot below [illegible] was attributed to an additional beta group. A.

539.163

3151. HIGH–ENERGY FORBIDDEN β–RAY TRANSITIONS FROM Cs^{134} (2.3 yr.), Co^{60} (5.3 yr.), Sc^{46} (84 d.), and Sc^{47} (47.9 d.). J.L.Wolfson.
Canad. J. Phys., Vol. 34, No. 3, 256–64 (March, 1956).

Beta–ray transitions of energies 1475 ± 6 keV from Co^{60} (5.3 yr) and 1475 ± 6 keV from Sc^{46} (84 d) were observed with intensities of (1.0 ± 0.2) x 10^{-4} and (3.6 ± 0.7) x 10^{-4} β–ray per disintegration respectively. Forbidden spectrum shapes were obtained for both transitions. An [illegible] was obtained for the β–ray transition of energy 1451 keV from Cs^{134} (2.3 yr nor for the transition of energy 475 keV from Sc^{47} (47.9 d). and upper limits of 5 x 10^{-5} and 3 x 10^{-4} β–rays per disintegration respectively are placed upon the [illegible] of these transitions. The log f_0t values are > 14.5, 14.0 ± 0.2, 13.6 ± 0.2,

nd > 11.3 for the transitions referred to from Cs^{134}, Co^{60}, c^{46} and Hg^{203} respectively. A.

539.165

152. K-CAPTURE IN THE DECAY OF CHLORINE 36.
.W.P.Drever and A.Moljk.
hil. Mag., Vol. 46, 1337-42 (Dec., 1955).

A search for the existence of K-capture in Cl^{36} has been ade using a proportional tube spectrometer with labelled ethyl chloride as a gaseous source. A peak which was observed in the beta spectrum corresponded to the K-radiation f sulphur and indicated the presence of K-capture. The ranching ratio K/β^- was found to be $(1.7 \pm 0.1)\%$. A scintilation spectrometer failed to detect any gamma-ray lines bove 20 keV with intensity greater than 10^{-4} of the beta intenity, so the observed K-capture transition goes to the ground tate of S^{36}. A.

539.165 : 539.166

153. BETA-GAMMA COINCIDENCE SPECTRUM OF THE X-COMPLEX. E.F. de Haan, G.J.Sizoo and P.Kramer.
hysica, Vol. 21, No. 10, 803-17 (Oct., 1955).

From coincidence measurements, made in a magnetic oincidence spectrometer, the maximum energies of the artial beta-spectra of UX_1 and UX_2 were found to be about 00 keV (UX_1), 600 keV and 1500 keV (UX_2), while furtherore some conversion lines due to gamma-gamma cascades ave been obtained. Possible decay schemes are discussed. A.

539.165 : 539.166

154. COINCIDENCE MEASUREMENTS ON THE β-DECAY F BORON 12. N.W.Tanner.
hil. Mag. (Ser. 8), Vol. 1, 47-54 (Jan., 1956).

A study of beta-gamma and gamma-gamma coincidences ssociated with the beta-decay of B^{12} has been made in order analyse the beta-spectrum. It is concluded that, relative the transition to the ground state of C^{12}, $(1.7 \pm 0.4)\%$ of the eta-transitions are to the 4.43 MeV excited state, and $\leq (0.0 \pm 0.2)\%$ to the 7.66 MeV state. A technique of comparion between B^{12} and Li^8 was used which incidentally gave a ew upper limit of $\leq (0.2 \pm 0.1)\%$ for gamma-radiation followng the Li^8 decay. A.

539.165.08

155. β-RAY SPECTROSCOPY IN THE PRECISION RANGE F 1 : 10^5. K.Siegbahn and K.Edvarson.
uclear Physics, Vol. 1, No. 3, 137-59 (1956).

An iron-free double focusing β-spectrometer for precision ork is described. Several conversion lines in the spectrum of h B + C have been measured absolutely, using a method which liminates the measurement of the magnetic field. By combing several such β-spectroscopic data one can calculate the lementary constant combination h/m_0c. The result is in excelent agreement with results obtained by other means. This is a ensitive check on the accuracy of the individual $B\rho$ values of he different lines. A.

539.166

156. CIRCULAR POLARIZATION OF GAMMA RADIATION MITTED BY ORIENTED ^{60}Co NUCLEI. J.C.Wheatley, .J.Huiskamp, A.N.Diddens, M.J.Steenland and H.A.Tolhoek.
hysica, Vol. 21, No. 11, 841-59 (Nov., 1955).

An experiment is described in which the circular polarzation of the gamma radiation emitted by polarized Co^{60} nuclei as measured. The detection of the circular polarization was erformed by measuring the change of the Compton scattering f the gamma radiation from magnetized iron when the direcon of the polarization of the nuclei is reversed. The nuclei re polarized in single crystals of $2Ce(NO_3)_3.3Mg(NO_3)_2.24H_2O$ ontaining about 110 μc Co^{60}, which are cooled by adiabatic emagnetization from a field of about 22 000 Oe and a temperture of about 1°K. A residual field of 280 Oe along the trinal axis causes a considerable degree of polarization of the nuclei, resulting in a degree of circular polarization as high as 75% at the lowest temperature, 0.006°K. The observed fractional change in counting rate E of the scattered gamma radiation upon changing the direction of the polarization of the nuclei relative to the direction of magnetization of the scattering iron amounted to at most 3%. The effect was clearly observable to temperatures up to 0.05°K. From the sign of the effect it can be concluded that the magnetic moment of Co^{60} is positive. The dependence of the effect on the temperature can be calculated theoretically starting from data on the h.f.s. in the crystal. When approximating this dependence by $E = a/T$ (in the region $1/T \leq 60$) an average experimental value $a_{exp} = 0.045$ ($\pm 10\%$) and an average theoretical value $a_{theor} = 0.0445$ were found. For lower temperatures ($1/T > 60$) there seems to be a significant difference between the experimental and theoretical values of E, which may be due to uncertainties in the knowledge of the hyperfine structure. A.

539.166

3157. GAMMA RADIATION IN THE DECAY OF ^{67}Ga.
L.H.T.Rietjens and H.J.van den Bold.
Physica, Vol. 21, No. 9, 701-18 (Sept.); Erratum, No. 12, 990 (Dec., 1955).

The level scheme of Zn^{67} has been investigated by scintillation coincidence spectrometry. Angular correlation measurements of the 206 keV-182 keV and 485 keV-296 keV gamma cascades results in anisotropies of -0.216 ± 0.008 and $+0.27 \pm 0.05$. The following spins have been allocated to the levels of Zn^{67}: ground state 5/2, 92 keV 3/2, 182 keV 5/2, 388 keV 3/2 and 870 keV 3/2. Evidence has been found for the existence of another level at 595 ± 10 keV, for which a spin of 5/2 is suggested. By delayed coincidences a value of 9.3 ± 0.2 microsec has been found for the half-life of the 92 keV metastable level in Zn^{67}. A.

539.166

3158. GAMMA RAYS FROM INELASTIC NEUTRON SCATTERING IN SODIUM AND IODINE. E.A.Wolf.
Phil. Mag. (Ser. 8), Vol. 1, 102-4 (Jan., 1956).

The γ-ray spectrum from inelastic scattering of 2.5 MeV neutrons in Na metal was measured with a NaI crystal spectrometer. γ-rays at 0.45 ± 0.01, 1.69 ± 0.03, and 2.2 ± 0.1 MeV are attributed to Na; the 1.69 MeV ray may be due to cascade decay of a 2.14 ± 0.04 MeV level. Further γ-rays observed at ~0.2, ~0.41, 0.64 ± 0.05 and 1.01 ± 0.05 MeV are attributed to iodine. J.J.Wilkins

539.166

3159. GAMMA RAYS IN THE DECAY OF BARIUM-131.
W.C.Beggs, B.L.Robinson and R.W.Fink.
Phys. Rev., Vol. 101, No. 1, 149-52 (Jan. 1, 1956).

Gamma-rays accompanying electron capture of 12 day Ba^{131} have been studied with a single-channel scintillation spectrometer. Relative intensities have been determined for the 122 keV (198), 214 keV (148), 372 keV (100), 496 keV plus satellite (360) and 620 keV (33) gamma-rays. Three new gamma-rays have been found at 823 ± 20 keV (2.0), 917 ± 15 keV (7.2) and 1032 ± 15 keV (11.0), and their assignment to Ba^{131} has been established by chemical purification and half-life. Crystal summing studies confirm that the 620 keV transition is the crossover of the 122 keV and 496 keV transitions, and no significant crystal summing is found for the three new gamma-rays. A peak corresponding to 83 keV was observed, which appears to be due to two or more unresolved gamma-rays, but no gamma-ray could be found at 100 keV. The decay of Ba^{131} was followed for 9 half-lives using an end window beta proportional counter, and the half-life was found to be 11.52 ± 0.08 days. The ratio of the pile neutron cross-section for the activation of Ba^{131} to that of long-lived Ba^{133} has been found to be $\sigma(Ba^{130})/\sigma(Ba^{132}) = 1.2 \pm 0.3$. A.

539.166

3160. NUCLEAR RESONANCE FLUORESCENCE IN Ge^{72}

AND Ge^{74}. F.R.Metzger.
Phys. Rev., Vol. 101, No. 1, 286-94 (Jan. 1, 1956).

With gaseous sources of As^{72} and As^{74}, large nuclear resonance fluorescence effects have been observed for the 835 keV excited state of Ge^{72} and for the 596 keV excited state of Ge^{74}. The angular distribution of the resonance radiation characterizes the spins of both these excited states as 2 and the spins of the ground states as 0. From the magnitude of the resonance fluorescence effects, the mean lives of the 835 keV and 596 keV gamma-ray transitions were determined as $(4.6 \pm 1.2) \times 10^{-12}$ second and $(1.9 \pm 0.3) \times 10^{-11}$ second, respectively. These lifetimes are approximately one order of magnitude shorter than those expected for electric quadrupole transitions on the basis of the single particle model. The influence of collisions in the gas on the observed resonance fluorescence effect was studied using the 596 keV level in Ge^{74}. A.

539.166

3161. ANGULAR CORRELATION OF GAMMA RADIATIONS FROM ORIENTED NUCLEI. P.S.Jastram, R.C.Sapp and J.G.Daunt.
Phys. Rev., Vol. 101, No. 4, 1381-8 (Feb. 15, 1956).

The angular correlation between the cascaded gamma-rays following the decay of Co^{60} nuclei oriented at low temperatures has been determined. Comparison with the directional anisotropy of the individual gamma-rays affords a test of the theory of Cox and Tolhoek largely independent of hyperfine interaction details and temperature determination. The theoretical predictions are confirmed. A.

539.166

3162. GAMMA-RAY ANGULAR DISTRIBUTION IN COULOMB EXCITATION. G.Breit, M.E.Ebel and J.E.Russell.
Phys. Rev., Vol. 101, No. 5, 1504-7 (March 1, 1956).

In view of discrepancies in the literature regarding signs in formulae for the angular distribution of gamma-rays emitted in Coulomb excitation, this distribution is worked out for the special case of $0 \rightarrow 2$ transitions. The calculation is quantum mechanical and neglects higher than first-order effects in the Coulomb energy. The signs and forms obtained are confirmed by a semiclassical calculation. A.

539.166 : 537.531

3163. ON THE ANGULAR CORRELATION DURING RÖNTGEN AND OPTICAL CASCADES. W.Moellering and J.H.D.Jensen.
Z. Phys., Vol. 144, No. 1-3, 252-5 (1956). In German.

The influence of the electron and nuclear spins on the angular correlation between two quanta emitted in successive transitions in the electron shells is discussed. For certain selected transitions the results are given explicitly. J.Hughes

539.166.08

3164. HIGH-DOSE MEASUREMENT BY OPTICAL ABSORPTION. J.F.Fowler and M.J.Day.
Nucleonics, Vol. 13, No. 12, 52-3 (Dec., 1955).

Changes in the optical absorption of polymethyl methacrylate and polystyrene were observed for dose rates up to 2×10^5 r (using Co^{60} gamma-rays and 220 kVp X-rays). The polystyrene absorption increased more or less linearly over the whole range, but the polymethyl methacrylate showed gradual saturation below 10^5 r. The decay with time of the absorption bands produced by the irradiation is discussed. L.R.Shepherd

539.166.08 : 537.542

3165. STUDIES WITH THE SCINTILLATION SPECTROMETER. R.K.Gupta and S.Jha.
Nuclear Physics, Vol. 1, No. 1, 2-8 (1956).

The setting-up of a single-crystal NaI—Tl spectrometer is described. The efficiency of the well-type crystal for gamma-rays has been determined by the summing technique. In the gamma-ray spectrum of I^{128}, in addition to the well known 440 keV gamma-ray, a gamma-ray of energy 960 ± 6 ke and two feeble gamma-rays of energy 520 keV and 750 keV hav been found. It has been argued that the 750 keV gamma-ray arises in the electron-capture branching, and the 960 keV and 520 keV gamma-rays arise in the β^--branching in the decay of I^{128}. A.

539.166.74

3166. ELASTIC SCATTERING OF GAMMA RAYS. A.K.Mann.
Phys. Rev., Vol. 101, No. 1, 4-8 (Jan. 1, 1956).

Gamma-rays of 0.411, 0.662 and 1.33 MeV were scattered from tin and lead targets and the absolute differential cross-sections for elastic scattering were measured at six angles between 15 and 90 degrees. At 0.411 and 0.662 MeV, the scattering is expected to be almost entirely Rayleigh scattering from the tightly bound electrons, and these data should therefore provide a reasonably stringent test of the theory of that process. However, the only calculations of Rayleigh scattering presently available are form-factor calculations which are expected to be inadequate for several reasons — in particular for neglect of electron binding in the intermediate state of the scattering process, and for certain nonrelativistic approximations — and consequently comparisons of experiment with the form-factor results are inconclusive. Nevertheless, for the scattering from tin at both 0.411 and 0.662 MeV, there is fair but possibly fortuitous agreement between experiment and form-factor calculations using Dirac wave-functions for the electrons; for lead at the same energies there are appreciable discrepancies particularly at the larger angles between the experimental results and similar calculations. In view of the latter discrepancies, it appears that unambiguous identificatio of the elastic scattering of gamma-rays by the electric field o a nucleus, i.e., potential scattering, cannot be obtained from measurements of the total elastic scattering by lead at 1.33 Me without improvements in the theory of Rayleigh scattering. A

539.166.7

3167. SCATTERING OF 2.62 MeV γ-RAYS BY THE ELECTRIC FIELD OF LEAD NUCLEI. L.Goldzahl, P.Eberhard, E.Hara and J.Mey.
C.R. Acad. Sci. (Paris), Vol. 242, No. 4, 484-6 (Jan. 23, 1956). In French.

A continuation of earlier measurements (Abstr. 8221/195 M.A.Grac

539.166 83

3168. ANGULAR CORRELATION MEASUREMENTS IN Te^{12} AND Te^{123}. N.Goldberg and S.Frankel.
Phys. Rev., Vol. 100, No. 5, 1350-4 (Dec. 1, 1955).

Measurements of the angular correlation of the two-step transition in Te^{121} and Te^{123} have been made using a thin Te source ($< 1\ \mu g/cm^2$). K-conversion-electron—gamma, L-conversion-electron—gamma and K-conversion—K-conversio cascades were investigated in both isomers using a thin lens beta-spectrometer as the fixed detector and scintillation coun ters for the movable detector. The measured correlation wa found to be of the form $1 + A_2P_2(\cos\theta)$ in agreement with the theoretically predicted angular correlation for the known spin sequence in the tellurium isomers ($11/2 \rightarrow 3/2 \rightarrow 1/2$). The measured values of A_2 corrected for geometry are -0.097 ± 0.004, -0.092 ± 0.009, -0.06 ± 0.03 for the K-γ, L-γ and K-K cascades respectively in Te^{123} and -0.015 ± 0.007, -0.007 ± 0.007 and -0.10 ± 0.04 for the same cascades in Te^{12} Comparison of the results of the K-γ cascades with theory shows that the second transition is a mixture of $(1.3 \pm 0.1)\%$ E2 and 98.7% M1 in Te^{123} and $(5.6 \pm 0.5)\%$ E2 and 94.4% M1 in Te^{121}. The ratio of reduced matrix elements is plus in both cases using the Biedenharn and Rose notation. The results for the K-K angular correlation are consistent with the K-γ correlations and are used to prove that the correlations, whi are smaller than the M4 - M1 correlation, cannot result from reduction of the M4 - M1 correlation by the action of extra-nuclear fields. A

539.166.83

169. COINCIDENCE STUDY OF THE SPECTRUM OF NTERNAL BREMSSTRAHLUNG ACCOMPANYING K CAPTURE N Cs^{131}. A.Michalowicz.
.R. Acad. Sci. (Paris), Vol. 242, No. 1, 108-10 (Jan. 4, 956). In French.

The spectrum has been measured in coincidence with the X-rays, with results in good agreement with theory (see bstr. 9893/1955). The arrangement and characteristics of the cintillation apparatus used is described briefly. J.J.Wilkins

539.166.83

170. RELATIVISTIC AND SCREENING EFFECTS IN RADIATIVE ELECTRON CAPTURE. R.J.Glauber, P.C.Martin, T.Lindqvist and C.S.Wu.
Phys. Rev., Vol. 101, No. 2, 905 (Jan. 15, 1956).

Theory and experiment for inner bremsstrahlung in A^{37} re in good agreement. G.E.Brown

539.166.83

171. AUGER EFFECT IN THE HEAVIEST ELEMENTS. .R.Gray.
hys. Rev., Vol. 101, No. 4, 1306-14 (Feb. 15, 1956).

The Auger effect in the heaviest elements has been inves-gated with magnetic beta-ray spectrometers. K-Auger yields r ytterbium, polonium and uranium of 0.064 ± 0.01, $0.058 \pm .005$ and 0.033 ± 0.010, respectively, were obtained. The -Auger electrons of ytterbium and polonium were resolved to two groups, K - LL and K - LX, according as two or one electrons were involved. The ratios of the intensities of the - LX electrons to the K - LL electrons for ytterbium and olonium were found to be 0.64 ± 0.05 and 0.55 ± 0.03, respec-vely. A summary of measurements of K-fluorescence yields nd K-Auger electron intensity ratios is given. A revised ecay scheme for Np^{236} and a redetermination of the half-life At^{211} (7.20 ± 0.05 hours) is included. A.

539.166.835

172. ON THE ENERGY DETERMINATION OF ELECTRON AIRS. E.Lohrmann.
Iuovo Cimento (Ser. 10), Vol. 2, No. 5, 1029-37 (Nov., 1955).

The limitations of determining the energy of electron pairs y means of their angular divergence are investigated by con-idering in detail the influence of multiple scattering. It is hown that at energies of the order of 1 GeV and higher the ivergence of pair electrons is essentially determined by ultiple scattering. A.

539.166.835

173. ANNIHILATION OF POSITRONS IN FLIGHT. W.Kendall and M.Deutsch.
ys. Rev., Vol. 101, No. 1, 20-6 (Jan. 1, 1956).

The cross-section for annihilation of positrons in flight s been measured for positron energies of 0.765, 1.02, 2.2 d 3.33 MeV. Positron energies were selected by means of a agnetic lens monochromator. A differential energy interval about 0.1 MeV was defined by the pulse height from an thracene crystal in which annihilation occureed. The annihi-tion radiation was detected in a scintillation counter biased to cord only quanta above 0.51 MeV. The angular distribution of e annihilation radiation and the total annihilation cross-ction, at all energies, agrees with the theoretical values ithin the experimental accuracy, estimated to be about $\pm 5\%$. A.

539.166.835

174. THE EFFECT OF FINITE NUCLEAR SIZE ON ELEC-RON PAIR PRODUCTION. E.H.S.Burhop.
roc. Phys. Soc. A, Vol. 69, Pt 2, 135-40 (Feb., 1956).

Calculations have been carried out of the energy and angu-ar distribution of the electrons produced in the process of pair roduction by incident quanta using Born's approximation and ssuming different forms for the distribution of electric charge on the nucleus. The effect of the finite charge distribution is large for large angle pairs produced by quanta of energy above 20 MeV, but there are only small differences between the effects to be expected for different distributions. A.

NUCLEAR REACTIONS 539.17

539.172

3175. NUCLEAR REACTIONS PRODUCED BY NITROGEN ON NITROGEN. H.L.Reynolds and A.Zucker.
Phys. Rev., Vol. 101, No. 1, 166-71 (Jan. 1, 1956

Excitation functions for the reactions (1) $N^{14}(N^{14}, N^{13})N^{15}$ and (2) $N^{14}(N^{14}, O^{15})C^{13}$ were determined from thick-target yields obtained with 26 MeV nitrogen ions on AgCN. The cross-section for both reactions at 25 MeV is about 5 millibarns. As the energy decreases, the cross-section for reaction (1) decreases more rapidly than for reaction (2). Neither N^{13} nor O^{15} was observed from the proton bombardment of Al^{27} at proton energies which lead to the same excitation in the compound nucleus. Further, it was found that reaction (1) proceeds through the ground states of N^{13} and N^{15} in more than 90% of the cases. The angular distribution of N^{13} in reaction (1) was measured for nitrogen energies of 16.3, 19.2, 21.1 and 23.3 MeV. The peak of the distribution at 23 MeV is at 50 deg in the centre-of-mass system. As the energy decreases, the angle at which the peak occurs increases. It is concluded that these reactions take place through a stripping process. A.

539.172

3176. SEMICLASSICAL APPROXIMATION TO COULOMB EXCITATION INTEGRALS. F.D.Benedict, P.B.Daitch and G.Breit.
Phys. Rev., Vol. 101, No. 1, 171-4 (Jan. 1, 1956).

Several numerical comparisons are made of the quantum-mechanical and semiclassical treatments of Coulomb excitation in the case of nonzero excitation. A detailed comparison is made of the part of the matrix element involving the impinging particle and also of the angular momentum weighting factors. It is found that the total cross-section is approximated very well by the semiclassical treatment. The partial cross-sections caused by different values of the orbital angular momentum L are represented by the semiclassical method with reasonable accuracy but the representation of radial integrals by their semiclassical approximations is even more accurate, especially for low L, the weighting factors containing L explicitly being appreciably different in the two cases. A.

539.172

3177. COMPARISON OF SEMICLASSICAL AND QUANTUM-MECHANICAL COULOMB EXCITATION INTEGRALS FOR LARGE L. R.L.Gluckstern, J.P.Lazarus and G.Breit.
Phys. Rev., Vol. 101, No. 1, 175-7 (Jan. 1, 1956).

Semiclassical and quantum-mechanical integrals occurring in the theory of Coulomb excitation are compared in the limit of distant collisions which corresponds to setting the usual parameter $\eta = 0$. The integrals are expanded in powers of the energy of excitation and are found to agree up to and including those of second order, provided the geometric mean of the initial and final energy is used in the semiclassical calculation. The results are generalized to include an arbitrary power law for the dependence of the interaction energy on radius. The agreement remains unchanged. A.

539.172

3178. ANGULAR DISTRIBUTION OF GAMMA RAYS IN COULOMB EXCITATION FROM Pt. F.D.Benedict.
Phys. Rev., Vol. 101, No. 1, 178-81 (Jan. 1, 1956).

A numerical calculation has been made of the angular correlation coefficient, $a_2(\xi)$, in Coulomb excitation in both

A

the quantum mechanical treatment and the semiclassical approximation. The parameters ξ and η were chosen to correspond to excitation of the 330 keV level of Pt^{194}. The radial integrals entering the quantum calculation have been evaluated in the semiclassical approximation. Both the classical and quantum calculations are found to reproduce the experimentally observed energy dependence of $a_2(\xi)$, and the quantum treatment gives rather satisfactory agreement with the experimental absolute values as well. A.

539.172

3179. GENERALIZATION OF THE LIQUID DROP MODEL OF FISSION. T.A.J.Maris.
Phys. Rev., Vol. 101, No. 1, 502-3 (Jan. 1, 1956).

The liquid drop model of fission is modified to allow for the difference between neutron and proton radii in heavy nuclei. Better agreement with experiment is achieved. J.M.Cassels

539.172 : 537.591.8

3180. SOLUTION OF THE FLUCTUATION PROBLEM IN THE CASCADE THEORY BY MEANS OF THE G-EQUATIONS OF JANOSSY WITHOUT IONIZATION LOSS. J.Łopuszański.
Ácta phys. Polon., Vol. 14, No. 3, 191–6 (1955).

A new method is given for solving the G-equations of Jánossy. The plane of the independent viariables (x, ϵ) is divided into bands: $1/(n+1) < \epsilon \leq 1/n$ (n = natural number). The solution for $\epsilon > 1$ may be easily found. Taking this solution into account, it is possible to linearize and solve the G-equations for $\epsilon > 1/2$. In each subsequent band (in the direction of increasing n) the equations can be linearized and solved in the same manner provided one knows the solution for the preceding band. Thus one obtains recurrent formulae together with explicit expressions for them for nucleon and electron-photon cascades. Graphical representations of the solution can be given. It is also shown that this method permits the factorial moments of the distribution to be obtained. A.

539.172

3181. HIGH-ENERGY NUCLEAR DISINTEGRATIONS.
M.Baldo-Ceolin and B.Sechi.
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1202-10 (Dec., 1955). In Italian.

Studies nuclear disintegrations produced by high-energy primaries (E_p 5 GeV or more), and to show how and in what manner the mesons created in the nucleus can influence the interaction. Disintegrations produced in nuclear emulsions exposed to cosmic radiation at an altitude of 27 km were studied. The ionization of the tracks, their energy distribution, their angular distributions and angular correlations, were analysed for 150 stars. Some phenomena such as the anomalous angular distribution of black tracks, i.e. the decrease of angular anisotropy with increasing energy of the nuclear disintegration, and the excess of angles near 180° between black and grey tracks, were interpreted as due to the reabsorption of π-mesons in the nucleus. The curve for the energy distribution of the grey prongs shows a step for energies below 100 MeV, which can be interpreted as being due to the scattering of π-mesons in nuclear matter. This hypothesis was adopted because the cross-section for scattering of pions in nuclei shows a maximum for a kinetic energy of the incident mesons of about 180 MeV, and the differential cross-section gives a prevalently backward scattering. This leads to the prediction that mesons created in the nucleus with energies of about 180 MeV will have much shorter scattering mean free path than other mesons, and that they will more frequently yield a large part of their energy to the recoil nucleon. These views have been checked by 500 "Monte Carlo" extractions to obtain the energy distribution curve of the protons emitted by the nucleus after a collision $\pi^+ + P - \pi^+ + P$. The spectrum which is thus obtained shows a marked variation in the region of 100 MeV. A.

539.172

3182. EVAPORATION NEUTRONS FROM COSMIC RAY NUCLEAR INTERACTIONS IN VARIOUS ELEMENTS.
K.W.Geiger.
Canad. J. Phys., Vol. 34, No. 3, 288-303 (March, 1956).

Production of evaporation neutrons from nuclear interaction by cosmic rays was investigated in C, Al, Fe, Cu, Pb and Bi. Boron trifluoride counters in a paraffin moderator in which the element under study was placed served to detect the evaporation neutrons. A cosmic-ray telescope allowed the consideration of ionizing neutron-producing particles separately and it was found that of the total neutrons 14.6% were produced by ionizing particles. The mean neutron multiplicities are worked out and they show an increase with the two-thirds power of the atomic weight of the element in which the interactions take place. Also, the rate of interactions is calculated and this gives the relative interaction cross-sections which are found to increase slightly more with atomic weight than expected if the cross-section is geometric. An estimate of the intensity of the N-component is made and discussed in connection with measurements published by other authors. A.

539.172

NUCLEAR REACTIONS DUE TO COSMIC RAYS. See also under "Cosmic rays". Decimal classification 537.591.8

539.172

3183. NUCLEAR CAPTURE OF NEGATIVE K MESONS IN EMULSION. W.F.Fry, J.Schneps, G.A.Snow and M.S.Swami.
Phys. Rev., Vol. 100, No. 5, 1448-55 (Dec. 1, 1955).

Thirty stars produced by stopped negative K mesons were found by area scanning in pellicles exposed to the Berkeley Bevatron accelerator. The ratio K^-/π^- at 90° to the incident 6.2 BeV proton beam was found to be $(0.76 \pm 0.11) \times 10^{-4}$ for an average momentum of 240 MeV/c. In four cases, charged hyperons were emitted from the stars, of which three are interpreted as Σ^+ hyperons and one as a Σ^- hyperon. In two additional cases the stopped K^- meson produced a hyperfragment. From 8 of the 30 stars, charged -mesons were emitted. The 30 events are all consistent with the production of a neutral or a charged hyperon upon the absorption of the K^- meson. The production ratio of Σ hyperons to Λ^0 hyperons is estimated to be of the order of 9/21. A.

539.172.11

3184. PROTONS FROM THE BOMBARDMENT OF SEVERAL ELEMENTS WITH 40-MeV ALPHA PARTICLES.
R.M.Eisberg, G.Igo and H.E.Wegner.
Phys. Rev., Vol. 100, No. 5, 1309-14 (Dec. 1, 1955).

Thin targets of Au, Ag and Cu were bombarded with 40 MeV alpha-particles and the energy distributions of protons emitted at 150° were measured. According to the compound-nucleus model, the level density of the residual nucleus is equal to: const $N/E\sigma_c$, where N is proportional to the probability that the compound nucleus emits a proton of energy E, and σ_c is the cross-section for the inverse reaction. For each element, $\log(N/E\sigma_c)$ plotted as a function of the excitation energy of the residual nucleus, E_r, is concave downward. This is in qualitative agreement with the Fermi gas level density formula: const $\exp(A E_r)^{1/2}$. For Au, $N/E\sigma_c$ fits this formula with $A = 5.8\ MeV^{-1}$ when $E_r > 2$ MeV; when E_r 2 MeV, $N/E\sigma_c$ increases less rapidly with increasing E_r than the formula. For Ag, $N/E\sigma_c$ fits with $A = 4.7\ MeV^{-1}$ for all E_r. For Cu, $N/E\sigma_c$ fits with $A = 5.6\ MeV^{-1}$ when $E_r > 4.5$ MeV; when $E_r < 4.5$ MeV, $N/E\sigma_c$ increases more rapidly than the formula. In the region of 150°, the cross-section for the emission of lower-energy protons is isotropic, but the cross-section for high-energy protons decreases slightly with increasing angle. Thus the energy distributions in the region of small E_r, are probably contaminated with protons from noncompound-nucleus processes. A.

539.172.11

3185. ALPHA-GAMMA REACTION. H.Morinaga.

Phys. Rev., Vol. 101, No. 1, 100-2 (Jan. 1, 1956).

The cross-section of the reaction $Ni^{58}(\alpha, \gamma)Zn^{62}$ was measured as a function of the incident alpha-particle energy from about 10 to 17 MeV. The cross-section at 17 MeV is about 0.4 mb and decreases gradually with decreasing energy. The experimental curve is compared with calculations assuming the formation of the compound nucleus. Two different gamma-ray width formulae are used; one is Weisskopf's single-particle formula for electric dipole radiation and the other is obtained from the known gamma-ray width derived from photo-nuclear absorption cross-sections. The former has about the right order of magnitude at the middle of the range investigated but behaves quite differently from the experimental curve. The latter shows fairly good agreement with the experiment, indicating the existence of the giant resonance. A calculation is also made for the reaction $Ni^{60}(p, \gamma)Cu^{61}$ cross-section and the results fit quite well again with the experimental cross-section reported by B.L.Cohen et al., indicating the possibility of explaining the reaction cross-section without the assumption of the "capture of the proton from the orbit". In both cases, the calculated values are too low at the high-energy side. This may be explained by some failure of the assumptions in the calculations. A.

539.172.11

3186. ALPHA EXCITATION FUNCTIONS OF SILVER AND COPPER. K.G.Porges.

Phys. Rev., Vol. 101, No. 1, 225-30 (Jan. 1, 1956).

The excitation functions for the production of some of the nuclei formed by alpha-particle bombardment of copper and silver have been measured for alpha energies up to 40 MeV. Comparison of these data with theoretical predictions based on (a) the assumption of relatively large radius constants ($r_0 = 1.5$ for Zn, $r_0 = 1.65$ for Cd) and (b) an energy-dependent odd-odd to even-even level density ratio allows two conclusions: (1) (α, pn) cross-sections are in good agreement with predictions based on the statistical theory. This lends some support to the proposal that the large (p, p), (p, pn), (n, p) etc., cross-sections recently reported are primarily due to indirect interactions. (2) With an energy level density $\omega = C\exp 2(aE)^{1/2}$, calculations based on the values of a deduced from inelastic scattering experiments do not fit the experimental curves; a derived from measured level spacing agrees with the copper, but not with the silver data. The best fit for the silver gives $a \cong 2$. This result, similar to that obtained by the analysis of other experimental data, suggests that there is a considerable excess of high-energy evaporated particles. A.

539.172.11

3187. INTERACTIONS OF 380-MeV ALPHA PARTICLES IN NUCLEAR TRACK EMULSION. D.S.Willoughby.

Phys. Rev., Vol. 101, No. 1, 324-8 (Jan. 1, 1956).

A study has been made of stars produced by 380 MeV alpha-particles in Ilford G.5 emulsion. The mean free path for star production is 18.4 ± 0.9 cm. The number of prongs per star varies from one to eight. The average number of prongs per star is 3.3. The striking feature of these stars is stripping, or splitting of the incident alpha-particle. This is evident in the large number of two-prong stars in which both prongs emerge with high energy at small angles to the beam direction; in the presence of one-prong stars, in which the single prong is a fast proton or deuteron emerging in nearly the forward direction; and in the very narrow angular distribution of the fast prongs. The star prongs have been divided into two groups, one group consisting almost entirely of cascade prongs, and the other consisting predominanly of evaporation prongs. The properties of the two groups of prongs are examined. It is found that the excitation produced by alpha-particles is similar to that produced by protons of the same energy, but the cascade differs in important respects. By observing the stars with prongs of energy lower than is necessary to escape the barrier of a heavy nucleus, one can identify 27% of the stars as originating in light nuclei. This places a lower limit on the number of events occurring in the gelatin. A.

539.172.11

3188. ALPHA-PARTICLE BOMBARDMENT OF A^{36} AND A^{40}. R.B.Schwartz, J.W.Corbett and W.W.Watson.

Phys. Rev., Vol. 101, No. 4, 1370-2 (Feb. 15, 1956).

Gas targets (130 keV thick) of natural argon (99.6% A^{40}; 0.34% A^{36}) and of argon enriched in A^{36} (97.4% A^{36}; 2.5% A^{40}) have been bombarded with 7.4 MeV alpha-particles from the Yale cyclotron. Protons and neutrons at 90° to the incident beam have been studied by means of 50 micron Ilford C-2 emulsions, placed 16 cm from the target. The ground-state Q-value for the $A^{36}(\alpha, p)K^{39}$ reaction is −1.28 MeV, with excited states at 2.50 and 2.87 MeV. The ground-state Q for $A^{40}(\alpha, p)K^{43}$ is −3.36 MeV, with excited states at 0.65 and 1.18 MeV. The cross-sections for these two reactions, as well as for the $A^{40}(\alpha, n)Ca^{43}$ reaction, have been measured and are found to be in general agreement with the predictions of simple compound-nucleus theory. A.

539.172.11

3189. $Li^7(\alpha, n)B^{10}$ REACTION. A.B.Robbins.

Phys. Rev., Vol. 101, No. 4, 1373-4 (Feb. 15, 1956).

This reaction has been investigated by two independent methods. In the first method the energies of the neutron groups were measured with a proton recoil telescope using an integral range technique. In the second method slow neutrons were observed at the threshold energies for each level with an enriched BF_2 counter. The combined results of the two methods give energy levels in B^{10} at excitation energies of 0.74 , 1.31 and 1.72 ± 0.06 MeV, with a ground-state Q value for the reaction of -2.82 ± 0.10 MeV. A comparative experiment with a Li^6 target was carried out so that positive assignment of the levels to B^{10} could be made. This work confirms the existence of a second excited state in B^{10} at 1.3 MeV excitation. The 1.3 MeV level had been observed in an early slow-neutron threshold experiment using the $Li^7(\alpha, n)B^{10}$ reaction, but it has not been found in other reactions leading to the same final nucleus. A.

539.172.11

3190. ELASTIC SCATTERING OF 40-MeV ALPHA PARTICLES FROM LIGHT ELEMENTS. G.Igo, H.E.Wegner and R.M.Eisberg.

Phys. Rev., Vol. 101, No. 5, 1508-14 (March 1, 1956).

The angular distribution for the elastic scattering of 40 MeV alpha-particles from C, Al, Ti, Cu, Nb, Mo and Ag has been measured. The angular distributions are characterized by strong diffraction patterns in contrast to the monotonically decreasing angular distributions of alpha-particles scattered from Ta, Au, Pb and Th. An analysis of the relative positions of the diffraction maxima yields a value for the interaction radius of $[(1.27 \pm 0.07)\, A^{1/3} + (1.60 \pm 0.23)] \times 10^{-13}$ cm. A comparison is made of the angular distributions measured at the energies of 19, 22, 40 and 48 MeV. A.

539.172.11 : 539.172.13

3191. $C^{12}(x, xn)C^{11}$ AND $Al^{27}(x, x2pn)Na^{24}$ CROSS SECTIONS AT HIGH ENERGIES. W.E.Crandall, G.P.Millburn, R.V.Pyle and W.Birnbaum.

Phys. Rev., Vol. 101, No. 1, 329-37 (Jan. 1, 1956).

The cross-sections were measured for protons (105 to 350 MeV), deuterons (85 to 190 MeV), and alpha-particles (380 MeV) by using a 4π β-counter to determine the absolute disintegration rate and measuring the incident flux with a Faraday cup. The absolute value of the $C^{12}(p, pn)C^{11}$ excitation function was found to be 13% lower than the value previously published for these energies, and was found to be constant between 200 and 350 MeV. The new value of this reaction cross-section removes some of the discrepancies between p-p scattering cross-sections measured elsewhere and those measured at Berkeley, and affects other experiments that use the reaction as a proton flux monitor. The other cross-sections

are in reasonable agreement with values determined by comparable methods. The relative excitation functions for $C^{12}(d, dn)C^{11}$ and $C^{12}(He^3, He^3n)C^{11}$ reactions were also measured by a stacked-foil technique using end-window counters. These were normalized to absolute values from the 4π counter data for deuterons. A.

539.172.13

3192. THE ABSOLUTE DETERMINATION OF RESONANT ENERGIES FOR RADIATIVE CAPTURE OF PROTONS BY SODIUM IN THE ENERGY RANGE BELOW 530 keV. D.A.Hancock and F.Verdaguer.
Proc. Phys. Soc. A, Vol. 68, Pt 11, 1080-1 (Nov., 1955).

Thin (0.8 keV) targets of NaCl were irradiated by the proton beam from an electrostatic generator; the resonance voltages were: 250.8 ± 0.2, 307.8 ± 0.3, 373.5 ± 0.4, 443.8 ± 0.6 and 510.9 ± 0.6. Relative yields and half-widths of the resonances are also given. A.O.Stanesby

539.172.13

3193. ENERGY LEVELS OF Be^8. C.D.Moak and W.R.Wisseman.
Phys. Rev., Vol. 101, No. 4, 1326-8 (Feb. 15, 1956).

The $Li^6(He^3, p)Be^8$ reaction has been used in a study of the levels of Be^8 up to an excitation energy of 14 MeV. The protons were observed with a NaI scintillation spectrometer. The ground state, the 2.9 MeV state, and, tentatively, a 12.3 MeV state were the only levels observed. No evidence was found for levels at 4.05, 4.9, 5.3 or 7.5 MeV. A.

539.172.13

3194. NUCLEAR REACTIONS AT MODERATE ENERGIES AND FERMI GAS MODEL. S.Hayakawa, M.Kawai and K.Kikuchi.
Progr. theor. Phys., Vol. 13, No. 4, 415-41 (April, 1955).

The cross-section for nucleon–nucleon collisions in nuclear matter is calculated in an analytical way on the basis of the Fermi gas model and the inverse-energy nucleon scattering cross-section. The mean free path thus derived is found to be in qualitative agreement with those deduced from the phenomenological analyses of scattering experiments at low as well as at moderate energies. The angular and energy distributions of knock-out nucleons are calculated and allow prediction of the contribution of such direct collisions to nuclear reactions. For the bombardment of 18 MeV protons on iron this contribution to the energy spectrum of emitted protons is found far smaller than that from the evaporation process. Nevertheless, this influence is not negligible in deducing the nuclear temperature. For the bombardment of 31 MeV protons the knock-out process can account for the gross behaviour of high-energy nucleons observed in experiments. A

539.172.13

3195. THE n-p CROSS SECTION IN THE RANGE 60-550 keV. W.D.Allen and A.T.G. Ferguson.
Proc. Phys. Soc. A, Vol. 68, Pt 11, 1077-80 (Nov., 1955).

Neutrons, produced by proton bombardment of a LiF target, were detected by a hydrogen-filled proportional counter set at 0° or 135° to the proton beam. A table is given comparing measured and theoretical n-p cross-sections and including values for the cross-section of carbon. D.R.Chick

539.172.13

3196. THE ANGULAR DISTRIBUTION OF $^7Li(p, n)^7Be^*$ NEUTRONS FOR PROTON ENERGIES BETWEEN 2.5 AND 2.9 MeV. R.Batchelor and G.C.Morrison.
Proc. Phys. Soc. A, Vol. 68, Pt 11, 1081-3 (Nov., 1955).

The previous work (Abstr. 7361/1955) has been extended by determining the angular distributions of the neutron groups from the $Li^7(p, n)$ reaction. A tentative interpretation for the angular distribution of those neutrons emitted when the Be^7 nucleus is left in the excited state, is put forward. J.Hughes

539.172.13

3197. ELASTIC SCATTERING OF PROTONS FROM Li^7. P.R.Malmberg.
Phys. Rev., Vol. 101, No. 1, 114-18 (Jan. 1, 1956).

Differential cross-sections for the elastic scattering of protons from Li^7 were measured over the energy range 1350 keV - 3000 keV at the centre-of-mass angles 70°, 90°, 110°, 130°, 150° and 167°. The various proton groups scattered from different elements in the lithium target and target backing were separated by a magnetic analyser. The 167° data agreed well with the earlier work at 166.3° by Bashkin and Richards. At all six angles the curves showed a maximum at about 2000 keV, a dip at 2230 keV, and an anomaly near the 1882 keV $Li^7(p, n)Be^7$ threshold. Exclusive of the anomaly, the energy dependence of the data suggests the presence of two interferring levels in Be^8. A.

539.172.13

3198. ANGULAR DISTRIBUTIONS OF DEUTERONS FROM (p, d) REACTIONS IN LIGHT NUCLEI. I. NITROGEN. K.G.Standing.
Phys. Rev., Vol. 101, No. 1, 152-7 (Jan. 1, 1956).

Deuterons have been observed from the reaction $N^{14}(p, d)N^{13}$, produced by 18.7 MeV protons. The deuterons were distinguished from proton background by a thin NaI crystal in a scintillation counter with the crystal thickness equal to the deuteron range. The angular distribution of deuterons to the N^{13} ground state was fitted by a curve calculated from Butler's theory for an angular momentum transfer $l_n = 1$. This shows that the ground states of N^{13} and N^{14} have opposite parity and is consistent with the assignment of $1+$ to the N^{14} ground state. The reduced width for the ground state transition is in qualitative agreement with that calculated using an independent-particle shell model with some indication that the N^{14} ground state is largely a D state. The transition $N^{14}(p, d)N^{13*}$ to the first excited state of N^{13} was not observed. The experimental upper limits on its cross-section give upper limits of a few % probability for admixtures of the configurations p^8s^2 and p^8sd in the N^{14} ground state. Application to the lifetime of C^{14} is discussed. A.

539.172.13

3199. ANGULAR DISTRIBUTIONS OF DEUTERONS FROM (p, d) REACTIONS IN LIGHT NUCLEI. II. LITHIUM, BERYLLIUM, BORON, FLUORINE, AND ALUMINUM. J.B.Reynolds and K.G.Standing.
Phys. Rev., Vol. 101, No. 1, 158-65 (Jan. 1, 1956).

Angular distributions of deuteron groups resulting from the bombardment of various elements with ~ 18 MeV protons have been observed. Angular distributions for reactions leading to the following final nuclei were studied: Li^6, Li^{6*} (2.2 MeV), Be^8, B^9, B^{9*} (2.4 MeV), B^{10}, F^{18}, Al^{26}. The observed data are fitted to theoretical (Butler) curves and in all cases, except F^{18} and Al^{26}, l_n (the angular momentum carried away by the picked up neutron) is found to be unity. For F^{18} and Al^{26}, l_n is found to be 0 and 2 respectively. Absolute cross-section measurements for some of the reactions are given and are compared with theory. A.

539.172.13

3200. (p, d) PICK-UP DEUTERON MEASUREMENTS AT 95 MeV. W.Selove.
Phys. Rev., Vol. 101, No. 1, 231-41 (Jan. 1, 1956).

Measurements in some detail have been made on carbon and beryllium, and a few measurements on other elements. On the Born approximation, the results can be analysed to give the momentum distribution of the picked up neutron, and consequently some information about its wave-function. The probable validity of this approximation at 100 MeV is examined, and seems reasonably good. The experimental results for carbon and for the pickup of a "tightly-bound" neutron from beryllium show strong high-momentum components indicating that the nuclear wave-function is not strictly of independent-

particle nature but that strong two-body interactions are operative inside the nucleus. There is also some indication of alpha-particle substructure in C and Be. A.

539.172.13

3201. REACTION $Li^6(p, \gamma)Be^7$. J.B.Warren, T.K.Alexander and G.B.Chadwick.

Phys. Rev., Vol. 101, No. 1, 242-5 (Jan. 1, 1956).

This reaction has been investigated by using protons of energy 0.4 to 1 MeV incident on isotopically separated Li^6 targets. Capture gamma radiation to the ground state and the 430 keV state in Be^7 has been observed; some 62% of the transitions go to the ground state. The ratio of intensities does not change significantly with energy, nor with angle of observation at E_p = 750 keV. The differential cross-section with the counter at 90% and E_p = 750 keV is about 2 x 10^{-32} cm^2/steradian. The combined angular distribution of the two gamma-rays is $1 + (1.05 \pm 0.15) \cos^2\theta$ at E_p = 750 keV. The Q value for the reaction is 5.66 ± 0.03 MeV in agreement with that calculated from mass values. A.

539.172.13

3202. EXCITATION FUNCTIONS AND ANGULAR DISTRIBUTIONS OF ALPHA PARTICLES LEADING TO THE GROUND AND FIRST EXCITED STATES OF Be^7 IN THE REACTION $B^{10}(p, \alpha)Be^{7*}$. J.W.Cronin.

Phys. Rev., Vol. 101, No. 1, 298-307 (Jan. 1, 1956).

Measurements on the excitation function and angular distribution of $B^{10}(p, \alpha)Be^7$, Be^{7*} have been carried out with apparatus which is an improvement over that used for previous measurements. Excitation functions have been measured at laboratory angles of 90° and 145° with respect to the bombarding beam, from 0.8 to 1.65 MeV. Angular distributions have been measured at 1.0, 1.2, 1.36, 1.5 and 1.63 MeV, and at 1.3, 1.5 and 1.63 MeV for the excited state. The excitation functions show resonances at 1.17 and 1.5 MeV for the ground state, and 1.55 MeV for the excited state transition. The resonances are superposed on a continuous isotropic background. The 1.17 MeV resonance shows nearly an isotropic distribution to the ground state. The 1.5 MeV state shows a distribution which is $1 - 0.53 \cos^2\theta$ with very small interference terms. The angular distributions leading to the excited state show a marked asymmetry with the backward angles favoured. The absolute cross-section at laboratory 90°, E_p = 1.5 MeV for the ground-state transition, is 21.1 ± 4 mb/sterad. This value is in reasonable agreement with previous work. The angular distributions are not inconsistent with an assignment of $3/2^-$ for the 9.70 MeV state and $7/2^+$ for the 10.06 MeV state in C^{11}. A.

539.172.13

3203. RECOIL STUDIES OF HIGH-ENERGY PROTON REACTIONS IN BISMUTH. N.Sugarman, M.Campos and K.Wielgoz.

Phys. Rev., Vol. 101, No. 1, 388-97 (Jan. 1, 1956).

The ranges in bismuth of Sr^{91}, Ba^{129} and Ba^{133m} recoil fragments from bombardment of bismuth with protons of 50 MeV to 2.2 BeV have been measured. The kinetic energies of the fragments have been calculated from the measured ranges and other reported range-energy data for fission fragments. The kinetic energy of the strontium recoils for all energies, and that of the barium recoils up to 450 MeV, can be explained as resulting from high-energy fission where most of the mass of the target is divided between two heavy fragments. At 2.2 BeV, the kinetic energy of the barium recoils is substantially smaller, consistent with a complimentary fragment of about 20 mass units. The energy deposition in the target nucleus for processes leading to strontium and barium nuclides was obtained from the ratio of recoils projected forward to those projected backward, and subsidiary calculations involving momentum and energy conservation. The calculated values of the energy deposited are substantially lower than the bombarding proton energies, and even somewhat lower than energy values calculated for production of the "fissioning nucleus" from radichemical data. Recoil experiments on spallation products, bismuth, lead and thallium, of masses 198 to 203, from high-energy proton bombardment of bismuth, indicate that thallium nuclides formed directly are produced in processes involving alpha-particle emission. A.

539.172.13

3204. PROTON CROSS SECTIONS OF Bi^{209}. C.G.Andre, J.R.Huizenga, J.F.Mech, W.J.Ramler, E.G.Rauh and S.R.Rocklin.

Phys. Rev., Vol. 101, No. 2, 645-51 (Jan. 15, 1956).

The cross-sections for the reactions $Bi^{209}(p, 2n)Po^{208}$, $Bi^{209}(p, n)Po^{209}$ and $Bi^{209}(p, \gamma)Po^{210}$ were measured for proton energies up to 10.65 MeV. The threshold for the (p, 2n) reaction is 9.65 MeV (c.m.) which leads to a neutron binding energy for Bi^{210} of ≥ 4.59 ± 0.14 MeV. The total cross-section as a function of energy agrees with the theoretical calculations for a radius $R = 1.5 A^{1/3} \times 10^{-13}$ cm. The energy dependence of the ratio of $\sigma(p, 2n)/\sigma(p, n) + \sigma(p, 2n)$ corresponds to a nuclear temperature of 4 MeV for Po^{209}. A.

539.172.13

3205. THE POLARIZATION OF γ-RADIATION FROM THE REACTIONS $^{27}Al(p, \gamma)^{28}Si$, $^{26}Mg(p, \gamma)^{27}Al$, $^{23}Na(p, \gamma)^{24}Mg$. I.S.Hughes and D.Sinclair.

Proc. Phys. Soc. A, Vol. 69, Pt 2, 125-34 (Feb., 1956).

Measurements of the polarization of some of the high energy γ-rays from these reactions have been made using nuclear emulsions impregnated with heavy water. The results obtained enable assignments of even parity to be made to the ground and first excited states of Al^{27} and to the ground state of Na^{23}. A range-energy relation for protons up to 5 MeV in wet emulsions is given in an appendix. A.

539.172.13

3206. ELASTIC SCATTERING OF 17-MeV PROTONS BY NUCLEI. I.E.Dayton and G.Schrank.

Phys. Rev., Vol. 101, No. 4, 1358-67 (Feb. 15, 1956).

The absolute differential cross-section for the elastic scattering of 17.00 ± 0.05 MeV (centre of mass energy) protons has been measured for twelve elements: Be, C, Al, Fe, Co, Ni, Cu, Zn, Rh, Ag, Pt and Au. Between 31 and 39 angles were taken for each element with a five degree (or less) interval ranging from 15 to 172 degrees. The estimated standard deviation of each point is 2.5%. The scattered protons are detected by a NaI(Tl) crystal whose energy resolution is about 2.5%, with the result that in the majority of cases all inelastically scattered protons are rejected. A.

539.172.13

3207. LEVELS OF Al^{25} FROM THE $Mg^{24}(p, \gamma)Al^{25}$ REACTION. D.S.Craig.

Phys. Rev., Vol. 101, No. 5, 1479-84 (March 1, 1956).

At the 222 keV resonance in the reaction $Mg^{24}(p, \gamma)Al^{25}$, a 2.05 ± 0.02 MeV gamma-ray in cascade with one of 0.454 ± 0.005 MeV, and a 1.56 ± 0.03 MeV gamma-ray in cascade with one of 0.97 ± 0.03 MeV have been observed. The intensities of the 2.05, 1.56 and 0.97 MeV gamma-rays are in the ratio of 100 : 14 : 5. The 2.05 MeV gamma-rays have a thick target yield of $(1.0 \pm 0.5) \times 10^{-11}$ γ/p, and exhibit an isotropic angular distribution with respect to the bombarding beam. The width at half-maximum of the resonance is less than 2 keV. The level in Al^{25} formed at the 222 keV resonance has an energy of 2.50 ± 0.02 MeV, and a spin and parity of $\frac{1}{2}\pm$ or $\frac{3}{2}+$, with the latter being a less probable assignment. A.

539.172.13

3208. LOW-LYING STATES OF F^{19}: REACTION $F^{19}(p, p')F^{19}$. B.J.Toppel, D.H.Wilkinson and D.E.Alburger.

Phys. Rev., Vol. 101, No. 5, 1485-92 (March 1, 1956).

The gamma radiation following inelastic proton scattering from F^{19} has been observed using 2.4 to 4.1 MeV protons from

a Van de Graaff generator. Gamma-rays of energies 1.238 ± 0.010 and 1.350 ± 0.010 MeV are observed in the singles NaI(Tl) spectrum using 3.0 MeV protons. The angular distributions of these gamma-rays show anisotropies of +29% and −29% respectively. Three-crystal pair-spectrometer measurements at 3.0 MeV and 3.5 MeV indicate that a 1.449 ± 0.010 MeV gamma-ray is also present. Coincidence measurements at 3.0 MeV show that gamma-rays of energies 1.233 ± 0.010 MeV and 1.346 ± 0.010 MeV are in prompt coincidence with 109 keV radiation while a 1.354 ± 0.010 MeV gamma-ray is in delayed coincidence with 197 keV radiation. These observations imply states in F^{19} at 1.342 ± 0.010 MeV, 1.452 ± 0.010 MeV, and 1.551 ± 0.010 MeV. The observed relative gamma-ray intensities show that the 1.24 MeV radiation originates mainly from the 1.34 MeV state and that the 1.34 MeV state exhibits less than an 8% branch to the J = 5/2 + level at 197 keV. These observations together with the fact that the 1.24 MeV radiation is nonisotropic indicate an assignment J = 3/2 for the 1.34 MeV state. A.

539.172.13

3209. NUCLEAR REACTIONS OF COBALT WITH PROTONS FROM 0- to 100-MeV ENERGY. R.A.Sharp, R.M.Diamond and G.Wilkinson.
Phys. Rev., Vol. 101, No. 5, 1493-504 (March 1, 1956).

Absolute excitation functions for 0 to 100 MeV protons on cobalt have been measured for 18 radioactive products from vanadium through nickel. Linear-accelerator bombardments in the 0 to 30 MeV region plus a scattered-beam cyclotron technique gave good energy resolution. The results are in qualitative agreement with the Bohr compound nucleus picture at low energies and a mixture of the Bohr and Serber mechanisms at higher energies. Evidence for high yields of alpha-particle emission was found. The influence of shell structure on yields was pronounced, with magic-number nuclei having especially low yields. A.

539.172.13 : 539.152.1

3210. ENERGY DEPENDENCE OF THE OPTICAL MODEL PARAMETERS. M.A.Melkanoff, S.A.Moszkowski, J.Nodvik and D.S.Saxon.
Phys. Rev., Vol. 101, No. 1, 507-9 (Jan. 1, 1956).

An analysis of the proton elastic scattering at 5.25 and 31.5 MeV, based on the diffuse surface optical model, when combined with previous results at 17 MeV, indicates the energy dependence of the model parameters. P.T.Matthews

539.172.13 : 539.172.4

3211. PRODUCTION OF DEUTERONS IN HIGH-ENERGY NUCLEON BOMBARDMENT OF NUCLEI AND ITS BEARING ON NUCLEAR CHARGE DISTRIBUTION. W.N.Hess and B.J.Moyer.
Phys. Rev., Vol. 101, No. 1, 337-50 (Jan. 1, 1956).

A study has been made of deuterons produced at wide angles to a beam of 300 MeV neutrons and a beam of 300 MeV protons. The cross-section dependence on atomic number for these deuterons for light elements can be written as $\sigma = kA^{1.2}$. This fact and the energy spectra and angular distribution of the deuterons show that the process that forms these deuterons is related to the indirect pickup process described by Bransden. This is a two-step process in which the incident nucleon, or its collision partner, is scattered and then picks up a deuteron-forming partner in the same nucleus. A yield of tritons has also been observed which has the same A-dependence and is presumably made by a similar process. The A-dependence of the deuteron-production cross-section also suggests that these deuterons are made on the nuclear surface. Because of this A-dependence, a comparison of the deuteron yields using an incident neutron beam and an incident proton beam can give information about the relative numbers of neutrons and protons on the surface of the nucleus. An analysis of this sort leads to a possible conclusion that for heavy nuclei there is a nuclear skin rich in neutrons. For light nuclei the effect is not observed. If this skin is composed only of neutrons its thickness must be about 0.8×10^{-13} cm for lead. A.

539.172.13

3212. TYPES OF COUPLING IN "STRIPPING" ANGULAR CORRELATIONS. O.Hittmair.
Z. Phys., Vol. 143, No. 4, 465-71 (1955). In German.

In the case of stripping e.g. (d, pγ) reactions where γ-radiation is emitted, the angular correlation (d—p—γ) depends directly on the angular part of the reduced width, which may be calculated for LS-, jj- and intermediate coupling on the basis of the shell model. The reaction $Li^7(p, d)\ Li^{6*}(\gamma)\ Li^6$ is taken as example. A.O.Stanesby

539.172.13

3213. REACTION (d, p) ON HEAVY NUCLEI. K.A.Ter-Martirosyan.
Zh. éksper. teor. Fiz., Vol. 29, No. 6(12), 713-29 (1955). In Russian.

In the case considered, the Coulomb field is primarily responsible for the reaction. General formulae are obtained, which not only are valid for large Z, but reduce to the Butler result for Z = O. For evaluation, approximations good for large Z and low E ($E < Ze^2/R_0$, where R_0 is the nuclear radius) are made. The final formula is also valid only for large angles, although total cross-sections are obtained in addition to angular distribution for medium and large angles. G.E.Brown

539.172.13

3214. NOTE ON THE NATURE OF (dp) REACTION. A.Basu (Mitra).
Indian J. theor. Phys., Vol. 2, No. 4, 185-6 (Jan., 1955).

It is shown that though the Q values of excited states in case of (d, n) reactions give several B_p values, the B_n values are not actually found from the corresponding Q values in (d, p) reactions, since in the latter case the proton levels are excited. A.

539.172.13

3215. ENERGY LEVELS IN F^{19} FROM A STUDY OF THE $O^{18}(d, n)F^{19}$ REACTION. M.V.Harlow, J.B.Marion, R.A.Chapman and T.W.Bonner.
Phys. Rev., Vol. 101, No. 1, 214-15 (Jan. 1, 1956).

A counter ratio investigation has been made of the $O^{18}(d, n)F^{19}$ reaction, using oxygen targets enriched to 40% O^{18}. A search was made for energy levels in F^{19} between excitation energies of 6.1 and 9.8 MeV. In this region, levels were found at 6.184 and 6.48 MeV. A resonance in the forward yield of neutrons from the deuteron bombardment of $O^{18}(d, n)$ reaction was measured by comparing the yield with that from the $O^{16}(d, n)$ reaction, the cross-section for which is known. A.

539.172.13

3216. INTERPRETATION OF (d, t) ANGULAR DISTRIBUTIONS. A.Werner.
Nuclear Physics, Vol. 1, No. 1, 9-19 (1956).

Expressions derived from stripping theory by Butler and Salpeter are used to obtain the upper limit of 0.11 for the probability of finding the triton in the configuration of deuteron ground state plus second neutron, utilizing the experimental data on angular distributions for the protons in C^{12} (d, p) C^{13} (J.Rotblat, 1951) and the tritons in C^{13} (d, t) C^{12} (Holmgren et al. 1954). A.

539.172.13

3217. SIMPLIFIED CALCULATION OF STRIPPING-PROCESSES. M.Kretzschmar.
Z. Phys., Vol. 144, No. 1-3, 168-76 (1956). In German.

In the calculation of stripping-process cross-sections, summations over spin orientations of the nuclei concerned may easily be obtained (without employing Clebsch—Gordan coeffs.) if they are used to form projection operators. A.O.Stanesby

539.172.13

3218. AN INVESTIGATION OF DEUTERON INDUCED REACTIONS BY MAGNETIC ANALYSIS. I. EXPERIMENTAL TECHNIQUE. T.S.Green and R.Middleton.
Proc. Phys. Soc. A, Vol. 69, Pt 1, 16-27 (Jan., 1956).

A magnetic spectrograph has been constructed for the measurement of the angular distribution of charged particles emitted in the deuteron bombardment of nuclei. The spectrograph utilizes the focusing properties of an axially symmetrical field and is capable of focusing protons and α-particles of 3 to 18 MeV and deuterons of 1½ to 9 MeV on a 12 in. long photographic plate, with an energy resolution of 0.25%. The instrument has been used in conjunction with the Liverpool 37 in. cyclotron for measurements over an angular range of 5^0 to 60^0 at a bombarding energy of 9 MeV. Due to the energy spread of the deuteron beam and the effect of target thickness the total experimental resolution was 0.5 to 0.6%. A.

539.172.13

3219. INVESTIGATION OF DEUTERON INDUCED REACTIONS BY MAGNETIC ANALYSIS. II. RESULTS FOR ^{9}Be, ^{12}C, ^{14}N AND ^{16}O. T.S.Green and R.Middleton.
Proc. Phys. Soc. A, Vol. 69, Pt 1, 28-42 (Jan., 1956).

Angular distributions have been measured of some of the proton, deuteron and α-particle groups emitted from targets of beryllium, carbon, nitrogen and oxygen when bombarded by 9 MeV deuterons. The proton angular distributions have been compared with those calculated from the stripping theories enabling assignments of spins and parities to be made to levels of the residual nuclei. Calculations have also been made of the relative capture probabilities and reduced widths and in the cases of carbon and nitrogen it was possible to express them in absolute units. A.

539.172.13

3220. CROSS SECTION AND ANGULAR DISTRIBUTIONS OF THE (d, p) AND (d, n) REACTIONS IN C^{12} FROM 1.8 TO 6.1 MeV. T.W.Bonner, J.T.Eisinger, A.A.Kraus, Jr and J.B.Marion.
Phys. Rev., Vol. 101, No. 1, 209-13 (Jan. 1, 1956).

The reaction $C^{12}(d, p)C^{13}$ has been studied from a deuteron bombarding energy of 1.8 to 6.1 MeV. Resonances were found at 2.47, 2.67, 2.99, 3.39, 4.00, 4.6, 4.8, 5.34 and 5.64 MeV. Angular distributions of protons leaving C^{13} in the ground state show a pronounced Butler peak at 25^0 over the entire deuteron energy range. The angular distributions can be explained by assuming small amplitudes for compound nucleus formation interfering with large stripping amplitudes. Angular distributions of the lower energy group of protons leaving C^{13} excited to 3.09 MeV show a pronounced Butler peak at 0^0 and an even smaller contribution of compound nucleus formation. The reaction $C^{12}(d, n)N^{13}$ was also studied, and showed similar resonances and angular distributions. An analysis is made of the phase difference between the resonant and nonresonant parts of the cross-section for the (d, p) reaction near the resonance at 4.00 MeV. A.

539.172.13

3221. ENERGY SPECTRUM OF NEUTRONS PRODUCED IN THE REACTION $Li^7(d, n)Be^8$. II. J.Catalá, J.Aguilar and F.Senent.
An. Real Soc. Españ. Fís. Quím., Vol. 51(A), No. 7-8, 173-84 (July-Aug., 1955). In Spanish.

For previous part see Abstr. 758 (1954). Only the lower neutron spectrum, corresponding to the higher energy levels in Be^8 was studied. A spectrum with many peaks was found. A discussion of all the possible reactions (d, n) is given and strong evidence is shown for four energy levels in Be^8 and two energy levels in Be^7. A.

539.172.13

3222. COMPARISON OF DIFFERENTIAL CROSS SECTIONS FOR THE REACTIONS $C^{12}(d, p)C^{13}$ AND $C^{12}(d, n)N^{13}$. R.E.Benenson, K.W.Jones and M.T.McEllistrem.
Phys. Rev., Vol. 101, No. 1, 308-10 (Jan. 1, 1956).

The differential cross-sections for these reactions to the ground states of the mirror nuclei C^{13} and N^{13} are reported for deuteron bombarding energies of 2.68 MeV and 3.26 MeV. The angular distributions at the forward angles are in agreement with those predicted from the formalism of Butler for both reactions. The cross-sections are compared at the angle of the first stripping peak, and this comparison indicates that the reduced widths of the mirror nuclei C^{13} and N^{13} are the same. This is in agreement with the assumption of the charge symmetry of nuclear forces. A.

539.172.3

3223. PHOTODISSOCIATION OF THE DEUTERON FROM 150 to 450 MeV. J.C.Keck and A.V.Tollestrup.
Phys. Rev., Vol. 101, No. 1, 360-70 (Jan. 1, 1956).

This has been investigated for laboratory photon energies of 150, 200, 250, 300, 350, 400 and 450 MeV at laboratory angles of 39, 56, 74, 93, 115 and 138 degrees. The process was identified by detecting the recoil protons in a range-ionization telescope. The total cross-section has a relative minimum at 150 MeV followed by a relative maximum at 250 MeV where its values are 53×10^{-30} cm^2 and 63×10^{-30} cm^2, respectively. From 150 to 250 MeV the centre-of-momentum angular distributions have a strong forward maximum which diminishes at higher energies until the distributions become approximately symmetrical. There is qualitative agreement with meson theories on some points. A.

539.172.3

3224. PHOTODISINTEGRATION OF THE DEUTERON. F.Zachariasen.
Phys. Rev., Vol. 101, No. 1, 371-6 (Jan. 1, 1956).

The Chew meson theory (Abstr. 8059/1954) has been applied in an attempt to describe the photodisintegration of the deuteron in the region of 100 to 400 MeV, and in particular to explain the appearance of a sort of resonance at about 250 MeV. The process is viewed as a meson photoproduction, followed by meson scattering in deuterium (treated in the impulse approximation) and absorption. The qualitative features of total cross-section are roughly reproduced, but the angular distribution does not seem to be fully understood on this model. A.

539.172.3

3225. PHOTODISINTEGRATION OF DEUTERIUM BY 60- TO 250-MeV X-RAYS. E.A.Whalin, B.D.Schriever and A.O.Hanson.
Phys. Rev., Vol. 101, No. 1, 377-84 (Jan. 1, 1956).

A liquid deuterium target was irradiated with X-rays from the 300 MeV betatron. Exposures were made at maximum bremsstrahlung energies of 165 MeV, 280 MeV and 300 MeV. The photoprotons produced were detected with Ilford G-5 nuclear emulsions. The distributions of protons as functions of energy were determined for laboratory angles of 30^0, 45^0, 75^0, 120^0 and 150^0. In the energy region from 60 MeV to 250 MeV the angular distributions are relatively flat but have considerable fore and aft asymmetries. The total cross-section, which was found not to vary greatly over this entire energy region, has a broad minimum of about 55 microbarns in the region of 150 MeV. A.

539.172.3

3226. ELASTIC PHOTOPRODUCTION OF π^0 MESONS FROM DEUTERIUM. J.W.Rosengren and N.Baron.
Phys. Rev., Vol. 101, No. 1, 410-12 (Jan. 1, 1956).

The differential cross-section for the reaction $\gamma + d \rightarrow \pi^0 + d$ has been measured for a broad spread (35 MeV) of γ-ray energies centered at about 280 MeV. The values as measured for three angles of the π^0 meson in the laboratory system are as follows:

$\theta(\pi^0)$	$d\sigma/d\Omega(\mu b/sterad)$
58°	9.0 ± 2.4
80°	4.7 ± 1.2
105°	2.8 ± 0.8

In addition to the above uncertainties based on counting statistics, there is an absolute uncertainty of about 20% because of uncertainties in detection efficiency and bremsstrahlung spectrum. The results are in good agreement with similar, earlier measurements at Cornell University and with the theory of Chappelear. A.

539.172.3

3227. EFFECT OF THE FINITE SIZE OF THE NUCLEUS ON μ-PAIR PRODUCTION BY GAMMA RAYS. G.H.Rawitscher.
Phys. Rev., Vol. 101, No. 1, 423-6 (Jan. 1, 1956).

The cross-section for μ-pair production by gamma-rays is calculated by using the Bethe–Heitler formula, taking into account the finite nuclear size. The cross-section is shown to be considerably smaller than that for a point-charge nucleus. A.

539.172.3

3228. NUCLEAR ELASTIC SCATTERING OF PHOTONS. E.G.Fuller and E.Hayward.
Phys. Rev., Vol. 101, No. 2, 692-700 (Jan. 15, 1956).

A NaI(Tl) scintillation spectrometer biased to detect only photons in the upper energy tip of a betatron-produced bremsstrahlung spectrum was used to measure the differential nuclear elastic scattering cross-section at 120 degrees as a function of photon energy from 4 to 40 MeV. The targets ranged in Z from Na to U. Total cross-sections are calculated by assuming a dipole angular distribution. The scattering cross-sections tend to exhibit two maxima, one below the particle threshold that corresponds to the scattering by separate levels, and one that follows the giant resonance for photon absorption. Both the maximum cross-section and the energy of the giant resonance vary smoothly with A from Na to U and are roughtly proportional to $(NZ/A)^2$ and $A^{-1/3}$, respectively. The dipole dispersion relation is used to compare the scattering data with the neutron yield data in the giant resonance region. A.

539.172.3

3229. OBSERVATIONS OF THE NUCLEAR INTERACTIONS OF A 315 MeV BREMSSTRAHLUNG γ-RAY BEAM. E.P.George.
Proc. Phys. Soc. A, Vol. 69, Pt 2, 110-24 (Feb., 1956).

The γ-ray beam was incident normally on Ilford G5 nuclear research emulsions, and events occurring in the emulsion were studied. The events have been analysed, and particular attention paid to interactions in which charged mesons leave tracks of length greater than 1.5 mm at right angles to the γ-ray beam. About 50% of the observed photomesons are not accompanied by visible nuclear disintegration "stars". The energy spectrum of the emulsion photomesons has been measured. The ratio of stars to mesons is found to be 11.4 : 1. These results are all consistent with a theoretical model proposed by Butler, in which meson production is considered to take place preferentially on the surface of atomic nuclei. Several high-energy electrons and electron-pairs moving at right angles to the γ-ray beam have been observed, and are accounted for. The observed cross-section for the production of stars with three or more prongs is 2.9×10^{-27} cm^2 nucleus^{-1}Q^{-1} in agreement with the result of Miller and disagreement with that of Kikuchi. The relation of these results to observations of the electromagnetic excitation of nuclei by fast charged particles is considered. A.

539.172.3

3230. THE PHOTODISINTEGRATION OF OXYGEN NUCLEI INTO FOUR ALPHA-PARTICLES. W.K.Dawson and D.L.Livesey.
Canad. J. Phys., Vol. 34, No. 3, 241-9 (March, 1956).

A total of 323 four-prong stars found in photographic plates exposed to bremsstrahlung of maximum energy 70 MeV have been identified as due to the disintegration of O^{16} nuclei into four alpha-particles. The excitation function of the reaction exhibits pronounced peaks at 22.5 MeV and 32.5 MeV as well as maxima at intermediate energies, and the integrated cross-sections for various energy ranges have been estimated. The mechanism of the process has been investigated and most of the disintegrations proceed via known excited levels in C^{12} and various states of Be^8. A.

539.172.4

3231. ON RADIATIVE CAPTURE OF THERMAL NEUTRONS WITHOUT FORMATION OF A COMPOUND NUCLEUS. L.K.Peker.
Zh. éksper. teor. Fiz., Vol. 29, No. 6(12), 865-6 (1955). In Russian.

In the capture of a thermal neutron by Pb^{206}, Pb^{207} in the +1/2 state is formed. The following neutron transition takes place to the ground $P_{1/2}$ level, permitted as a single particle state, rather than to the $P_{3/2}$ state which would involve core participation. G.E.Brown

539.172.4

3232. ON THE CAPTURE OF THERMAL NEUTRONS BY LEAD ISOTOPES. A.V.Shum'ko and D.F.Zaretskiĭ.
Zh. éksper. teor. Fiz., Vol. 29, No. 6(12), 866-8 (1955). In Russian.

Level systems in Pb^{207} and Pb^{208} are considered. An estimate of the cross-sections for capture by Pb^{207} employing single-particle wave functions (see preceding abstract) gives a result in agreement with experiment. G.E.Brown

539.172.4

3233. THE EXCITATION CURVES OF SOME (n, p) PROCESSES INDUCED BY NEUTRONS OF 12.5-17.5 MeV ENERGY. A.V.Cohen and P.H.White.
Nuclear Physics, Vol. 1, No. 2, 73-84 (1956).

The excitation functions of the reactions $Mg^{24}(n, p)$, $Si^{28}(n, p)$, $Cl^{37}(n, p)$, $Sr^{88}(n, p)$, $Cu^{63}(n, 2n)$ and $Zn^{64}(n, 2n)$ have been measured, using neutrons of energies between 12.5 MeV and 17.5 MeV from the T(d, n) reaction. The significance of the results is discussed from the viewpoint both of the theory of the compound nucleus and a theory of direct interaction. A.

539.172.4

3234. MEASUREMENTS OF INELASTIC SCATTERING CROSS SECTIONS FOR FAST NEUTRONS. J.J.Van Loef and D.A.Lind.
Phys. Rev., Vol. 101, No. 1, 103-13 (Jan. 1, 1956).

Cross-sections for inelastic neutron scattering by Fe, Mn, I and F have been measured with a collimated neutron beam by observing the gamma radiations from the excited states. Excitation curves for the 850 keV level of Fe^{56}, the 128 keV level of Mn^{55} and the levels at 62, 208, 435 and 632 keV in I^{127} were compared with the Hauser-Feshbach theory. The nuclear penetrabilities were obtained from the "cloudy crystal ball" model. In general, the best agreement with theory was obtained for the value of the nuclear absorption corresponding to a "black" nucleus. The angular distribution of the 850 keV radiation from Fe^{56} was given by $W(\theta) = 1 + (0.54 \pm 0.05)P_2(\cos\theta) - (.028 \pm 0.05)P_4(\cos\theta)$. Excitations of levels at 980 keV in Mn^{55}; at 390, 725 and 950 keV in I^{127}, and at 110, 197 and 1560 keV in F^{19} were also observed. No levels in S^{32} or Sr below 1 MeV were found. The excitation curves cannot be used to determine spins of excited states and even where spins and parities are known the agreement with theory is not good. A.

539.172.4

3235. CROSS SECTION FOR THE $Si^{28}(n, p)Al^{28}$ REACTION. J.B.Marion, R.M.Brugger and R.A.Chapman.
Phys. Rev., Vol. 101, No. 1, 247-9 (Jan. 1, 1956).

By observing the radioactivity induced in glass samples bombarded by monoenergetic neutrons from the d-d reaction,

the excitation function and the absolute cross-section for the $Si^{28}(n, p)Al^{28}$ reaction have been measured for neutron energies from 4.4 to 8.0 MeV. In this energy region several resonances were found and the maximum cross-section was measured to be 0.37 barn. A.

539.172.4

3236. NEUTRON CROSS SECTIONS FOR ZIRCONIUM. J.B.Guernsey and C.Goodman.
Phys. Rev., Vol. 101, No. 1, 294-7 (Jan. 1, 1956).

The inelastic neutron cross-section for the excitation of the 930 keV level in zirconium has been measured as a function of neutron energy between 0.9 and 2.2 MeV. The de-excitation gamma radiation has been observed with a single crystal NaI(Tl) spectrometer. Isotopic assignment of the observed level is still uncertain. The total cross-section for zirconium has been measured for neutrons with energies between 0.7 and 1.2 MeV, using a hydrogen recoil counter in a good-geometry transmission experiment. Some correlation between inelastic and total cross-sections has been observed. A.

539.172.4

3237. EXCITATION OF SOME LOW-LYING LEVELS BY INELASTIC NEUTRON SCATTERING. J.B.Guernsey and A.Wattenberg.
Phys. Rev., Vol. 101, No. 5, 1516-23 (March 1, 1956).

The de-excitation gamma radiation following inelastic scattering of neutrons has been studied for eight elements (of normal isotopic abundance) with excited states between 100 and 350 keV. A thin NaI (Tl) crystal spectrometer was used as a gamma-ray detector. Yield curves for the gamma-rays from low-lying levels in manganese, iodine, hafnium, tantalum, wolfram, rhenium, platinum, and gold have been obtained as a function of neutron energy for neutrons from 100 to 1800 keV. In some cases these yield curves represent a composite of gamma radiation from the directly excited states under observation, and cascade radiation from higher excited states. A comparison of the yield with total inelastic scattering cross-sections requires a complete knowledge of the decay schemes. This is discussed for the individual elements. In the cases of Mn, I, and Re cross-section values obtained represent that part of the total inelastic cross-section which arises from the excitation of a single known level. Agreement of the excitation curves with Hauser-Feshbach theory is good in most cases. No large unanticipated effects seems to arise in the inelastic scattering of neutrons from levels known to be rotational. A.

539.172.4

3238. FISSION OF HEAVY NUCLEI BY HIGH ENERGY NEUTRONS. V.I.Gol'danskiĭ, V.S.Pen'kina and E.Z.Tarumov.
Zh. éksper. teor. Fiz., Vol. 29, No. 6(12), 778-89 (1955). In Russian.

The fission of U^{235} and U^{238} by neutrons of energies 120 and 380 MeV, the excitation function for the fission of Bi in the region 120-380 MeV and fission of Th, Pb, Tl, Au, Pt and W by neutrons of 380 MeV were studied. Fragments were detected in an ionization chamber. Cross-sections for fission are given for the above elements. The mechanism of fission at these energies is discussed and various parameters in the theory are determined from this and other experimental evidence. G.E.Brown

539.172.4

3239. SYSTEMATICS OF FISSION THRESHOLDS. W.J.Swiatecki.
Phys. Rev., Vol. 101, No. 1, 97-9 (Jan. 1, 1956).

An examination of the experimental data on fission thresholds and ground state masses of nine nuclei shows that (i) there is experimental evidence for a difference between the masses of even-even, odd-A and odd-odd nuclei in the deformed saddle point configurations, analogous to the well known difference for the ground states, (ii) the trend with Z^2/A in the saddle-point masses is consistent with simple theoretical estimates based on a liquid drop type of model. This leads to a semiempirical formula for fission thresholds, which is found to be consistent also with estimates of thresholds made with the aid of the observed spontaneous fission half-lives of 28 nuclei. An analogous semiempirical formula for spontaneous fission half-lives is given. A.

539.172.4

3240. FISSION THEORY AND SEMIEMPIRICAL MASS FORMULA. T.A.J.Maris.
Phys. Rev., Vol. 101, No. 1, 147-8 (Jan. 1, 1956).

The fission theory of Bohr and Wheeler employs the semi-empirical mass formula with the following constants: E_S (= surface energy) = $14A^{\frac{2}{3}}$ MeV; $x = E_{Coulomb}/2E_S = (1/47.8)(Z^2/A)$; nuclear radius = Coulomb radius = $1.47 \times 10^{-13} A^{\frac{1}{3}}$ cm. The experimental masses deviate systematically from the values calculated using this formula. In the present note it is shown that these differences may severely influence the results of the fission theory. A reduction of the standard error in the mass formula from 8 to 2 mMU has been achieved by using the following constants: $E_S = 17.8A^{\frac{2}{3}}$ MeV; Coulumb radius = $1.216 \times 10^{-13} A^{\frac{1}{3}}$ cm; $x = (1/50.1)(Z^2/A)$. The smaller x-value and Coulomb radius, in addition to possible shell effects in the two halves of the deformed nucleus, decrease the stability of a symmetric deformation of the nucleus. A.

539.172.4

3241. RANGE AND RANGE DISPERSION OF SPECIFIC FISSION FRAGMENTS. W.M.Good and E.O.Wollan.
Phys. Rev., Vol. 101, No. 1, 249-53 (Jan. 1, 1956).

The range and dispersion in range of specific U^{233} and U^{235} fission fragments; namely, those associated with delayed-neutron emitters, have been determined in gases of different atomic number. These measurements give the Z-dependence of the range and range dispersion for fragments associated with a specific mode of fission. After corrections for foil thickness and geometry the Z-dependent part of the range dispersion which arises from the nuclear stopping process was determined and values were obtained for the residual component corresponding to the energy dispersion associated with the fission process itself. The values thus obtained for this energy dispersion are found to be in fair accord with recent theoretical results of Fong. A.

539.172.4

3242. SEARCH FOR Be^{10} AS A PRODUCT OF TERNARY FISSION. K.F.Flynn, L.E.Glendenin and E.P.Steinberg.
Phys. Rev., Vol. 101, No. 5, 1492 (March 1, 1956).

The possibility of the formation of Be^{10} as a product of ternary fission of U^{235} has been investigated radio-chemically. An upper limit of 4×10^{-4}% fission yield was determined. This low value is inconsistent with the recently proposed assignment of the 0.15 sec delayed-neutron period to Li^9. A.

539.172.4

3243. ENERGY OF THE DELAYED NEUTRONS FROM THE FISSION OF U^{235}. T.W.Bonner, S.J.Bame, Jr and J.E.Evans.
Phys. Rev., Vol. 101, No. 5, 1514-15 (March 1, 1956).

The energy distribution of neutrons from the short-lived neutron emitters produced in the thermal fission of U^{235} has been determined with a cloud chamber. A continuous energy distribution was obtained with a maximum number of neutrons at the lowest energies and a few neutrons with energies of at least 2.4 MeV. A linear plot of (number of neutrons)$^{1/5}$ v. the neutron energy is obtained indicating an extrapolated neutron energy of 3.5 MeV. A.

539.172.4

3244. CRITICAL ASSEMBLIES AT LOS ALAMOS. H.C.Paxton.
Nucleonics, Vol. 13, No. 10, 48-50 (Oct., 1955).

The fast-neutron critical assemblies at Los Alamos are Godiva, a bare U^{238} sphere: Topsy, a small U^{235} core

surrounded by a natural U reflector, and, Jezebel, a bare Pu sphere. Godiva can be taken into the prompt critical regime by firing a U^{235} slug into the assembly, thereby producing a power divergence with a period of about 15 microsec. The power level rises to 1000 MW but falls off equally rapidly as thermal expansion reduces the reactivity below critical. The pulse has a duration of 50 microsec at half height and produces 10^{16} fissions. Samples of fissile materials irradiated during the bursts are rapidly transferred to a neutron counter immediately afterwards, in order to measure delayed neutrons. The periods, relative abundances and absolute yields of the delayed neutrons from U^{238}, U^{238}, Pu^{239} and Th^{232}, measured in this manner are tabulated. L.R.Shepherd

539.172.4

3245. FISSION-PRODUCT BUILD-UP IN LONG-BURNING THERMAL REACTORS. W.L.Robb, J.B.Sampson, J.R.Stehn and J.K.Davidson.
Nucleonics, Vol. 13, No. 12, 30-3 (Dec., 1955).

Neutron poisoning in a thermal reactor, due to stable fission-products, is calculated for prolonged operation up to 10 burn-ups of the original U^{233} or U^{235} fuel, assuming a constant fission-rate and that the fuel concentration is kept constant by breeding or adding fresh fuel. The calculations are based upon best available data on fission product yield curves and cross-sections. Xe^{135} and Sm^{149} are taken into account in a reactor assumed to have a thermal neutron flux of 10^{14}n/cm^{-2}.sec^{-1}. The distributions of poisoning between the various fission products are tabulated for different burn-ups and the effects of removing some or all the fission products that occur as gases, are described. L.R.Shepherd

539.172.4

3246. HOW TO CONTROL A BOILING REACTOR. N.MacPhee.
Nucleonics, Vol. 13, No. 12, 42-5 (Dec., 1955).

The large density changes in moderator, resulting from the formation of vapour and the strong interdependence of steam pressure andvapour fraction in the core, complicates the control problem of the bofling reactor. A servo analogue of a boiling reactor power plant is described. Conditions for stable operation, i.e. with a negative power coefficient of reactivity, are discussed. Three methods of control responding to steam output pressure are outlined. These involve (i) steam dumping, (ii) use of control rods, (iii) variation of speed of recirculation of the liquid moderator. L.R.Shepherd

539.172.4 : 536.629

A CALORIMETER FOR MEASURING ENERGY ABSORPTION FROM PILE RADIATION. See Abstr. 2048

539.172.4 : 621.039.4 :621.317.7 : 621-52

3247. THE CONTROL AND INSTRUMENTATION OF A NUCLEAR REACTOR. A.B.Gillespie.
Proc. Instn Elect. Engrs, Paper No. 2058 M, publ. March, 1956, 13 pp. To be republished in Vol. 103 B (1956).

A survey of the overall instrumentation of a typical research reactor is presented. Emphasis is placed on the less-well-known problems of measurement and control, and a brief account is given of the mode of operation of a nuclear reactor, and a short section on reactor kinetics is included. The types of instruments in present-day use are described, and indications are given of their shortcomings. The principles of safety-circuit design are outlined, and examples are given of instruments and circuits which conform to this basic code and which have been used on a number of experimental reactors at Harwell. A.

539.172.4 : 621.039.42 : 621-52

3248. THE CONTROL OF NUCLEAR REACTORS. R.J.Cox and J.Walker.
Proc. Instn Elect. Engrs, Paper No. 2068 M, publ. March, 1956, 13 pp. To be republished in Vol. 103 B (1956).

The physical principles of nuclear reactors which affect the design of their control and instrumentation are described. Data are presented for the kinetic behaviour of the neutron flu for reactivity changes in a variety of reactor types. The nuclear reactions inherently produce various nuclides, and the effects of these on reactor control and operation are discusse These nuclides include the delayed-neutron emitters, which cause a slowing down of the reactor kinetic response; β- and γ-emitters, which continue to produce heat for a long time after the neutron reactions producing them have been shut dow and the fission-product poisons. Reasons are given for the system of neutron-flux instruments normally used, and details are given of the principles of design of the various types of instrument. A.

ATOM AND MOLECULE BEAMS. MESONS. NEUTRONS 539.18

539.18

3249. NEW RESULTS ON ELEMENTARY PARTICLES AT THE PISA CONFERENCE (12-18 JUNE, 1955). P.H.Fowler.
Nuclear Physics, Vol. 1, No. 1, 67-71 (1956).

Brief progress report.

539.18

3250. EXPERIMENTS WITH SLOW K MESONS IN DEUTERIUM AND HYDROGEN. K.M.Case, R.Karplus and C.N.Yang.
Phys. Rev., Vol. 101, No. 1, 358-9 (Jan. 1, 1956).

It is pointed out that the following useful information can be obtained from experiments on K-mesons in deuterium and hydrogen: (a) an indication of the K-particle spin; (b) a test of isotopic spin conservation in reactions involving strange particles; (c) a measurement of the Σ^0 mass. A

539.18

3251. NOTE ON HYPERFRAGMENTS. J.T.Jones, Jr and J.K.Knipp.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 857-9 (Oct., 1955).

Data are classified in terms of isotopic spin doublets, triplets and quartets. G.E.Brow

539.18

3252. SPECULATIONS ON HEAVY MESONS. T.D.Lee and J.Orear.
Phys. Rev., Vol. 100, No. 3, 932-3 (Nov. 1, 1955).

It is beginning to appear that the χ-meson and the τ-mes are different particles although their observable lifetimes and masses are the same. It is proposed that there exist two heav mesons, the χ and the τ, one slightly heavier and having a significant branching ratio for γ-decay into the lighter one. Both mesons may contribute to the $K_{\mu 2}$, $K_{\mu 3}$ and K_{e3} modes of decay while the χ might contribute to the $K_{\pi 3}$ unless the spin of the χ was 0^+. The various cascade possibilities are discussed, to distinguish between them it is important to know whether the τ^0 exists and whether the τ^+ is produced in association with a single Λ^0 or Σ-hyperon. D.J.Prows

539.18

3253. COMPOUND HYPOTHESIS FOR THE HEAVY UNSTABLE PARTICLES. II. M.Goldhaber.
Phys. Rev., Vol. 101, No. 1, 433-8 (Jan. 1, 1956).

The compound hypothesis for hyperons and heavy mesons is restated, modifying an earlier assumption (Abstr. 1742/1954) on the isotopic spin of θ^0.θ mesons and $\bar{\theta}$ mesons (anti-particles) are assumed to have isotopic spin $T = \frac{1}{2}$, as propos by Gell-Mann. The total number of heavy mesons (θ mesons minus $\bar{\theta}$ mesons) is conserved in strong interactions (fast reactions). The fundamental reaction is thus pair creation of $\theta + \bar{\theta}$, with θ mesons free and $\bar{\theta}$ mesons either free or bound to nucleons ($\mathfrak{N}$). Hence $\mathfrak{N} + \bar{\theta}$ can form $T = 0$ and $T = 1$ multi-

plets which are identified with the Λ^0 singlet and the Σ triplet, respectively. The facts known about hyperons, associated production, and interaction of heavy mesons with nucleons are consistent with the author's assumptions. A discussion of T-multiplets among hypernuclei is given. Some experiments which may throw new light on the compound hypothesis are discussed. A.

539.18

3254. AN UNUSUAL DOUBLE V-EVENT AT SEA-LEVEL. J.L.Lloyd and A.W.Wolfendale.
Phil. Mag. (Ser. 8), Vol. 1, 93-6 (Jan., 1956).

In the course of a cosmic-ray μ-meson scattering investigation using a multiplate cloud-chamber under the Manchester spectrograph, an event was observed in which two V^0-particles were emitted in opposite directions from an interaction due to a ~ 2 BeV/c (momentum) proton or π-meson. Analysis by the Armenteros–Podolansky method indicated that at least one of the V^0-particles was a Λ^0. Two body decay of a particle at rest (suggested by the collinearity) was ruled out by momentum considerations. Double production with subsequent scattering is suggested, the collinearity being then fortuitous.
R.H.W.Johnston

539.18

3255. UNSTABLE $_1H^4$ FRAGMENT FROM THE CAPTURE OF A Σ^- HYPERON. M.Schein, D.M.Haskin and D.Leenov.
Phys. Rev., Vol. 100, No. 5, 1455-6 (Dec. 1, 1955).

A 10 x 15 x 5 cm stack of Ilford G-5 emulsion was exposed to the 3.0 BeV π^--meson beam of the Berkeley Bevatron. A number of events involving K-mesons, hyperons, and hyperfragments were observed. One interesting case is discussed here. A nine prong star is produced by a π^- meson, from which a Σ^- hyperon emerges. This in turn produces a star with three visible prongs, one of which is a $_1H^4$-hyperfragment decaying into two visible colinear tracks, one of which has been identified as a π^- meson. This π^- meson was followed to the end of its range, and its energy was determined to be 51 ± 1 MeV, making it possible to calculate a reliable value for the binding energy of the Λ^0 in the fragment. The result yielded 3.3 ± 1 MeV. Analysis of the particles emerging from the Σ^- star showed that momentum balance could be achieved by assuming emission of a high-energy neutron, whose calculated energy of 41 MeV agrees well with the energy of 42 MeV for a neutron produced in the postulated elementary interaction $\Sigma^- + p \rightarrow \Lambda^0 + n + Q$. A.

539.18

3256. Λ^0-FRAGMENT DECAY IN A CLOUD CHAMBER. J.D.Sorrels, G.H.Trilling and R.B.Leighton.
Phys. Rev., Vol. 100, No. 5, 1484-6 (Dec. 1, 1955).

The decay in flight of a heavy nuclear fragment is described. The event is most reasonably interpreted as the decay of a Λ^0 particle bound to a He^3 nucleus, and is similar to examples previously observed in nuclear emulsions. The lifetime of the excited fragment in this single example is $5.4 \pm 0.6 \times 10^{-10}$ sec, and the binding energy of the Λ^0 to He^3 is probably less than 2 MeV. A.

539.18

3257. ANOMALOUS NEUTRAL V-PARTICLES. W.H.Arnold, Jr, W.Martin and H.W.Wyld.
Phys. Rev., Vol. 100, No. 5, 1545-7 (Dec. 1, 1955).

A search has been made for anomalous neutral decays among photographs of V-events obtained from the Princeton cloud chamber. 82 neutral V-particles have been analysed giving 30 Λ^0s, 31 θ^0s, 21 Λ^0 or θ^0 and 5 anomalous events. An event is considered anomalous if the Q-value calculated for the decay on the basis of either the Λ^0 or θ^0 scheme is more than three standard deviations from either known Q-value, or if the neutral particle and the V-event are not co-planar. Full details of all such anomalous decays are given. D.J.Prowse

539.18

3258. A PROBABLE EXAMPLE OF THE REACTION: $\pi^- + p = K^+ + K^- + n$. M.Ceccarelli, M.Grilli, M.Merlin, G.Salandin and B.Sechi.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 828-40 (Oct., 1955).

An event is described in which a fast singly charged particle produces a star from which the only charged particles emitted are a negative K meson and another particle of about 1000 electronic masses. The interest of the event is due to the fact that this is the first case in which a mechanism of creation of a negative K-meson can be specified with a good degree of reliability. The event is shown to be in agreement with the selection rules resulting from associated production ideas.
A.

539.18

3259. A τ^+ DECAY WITH A VERY LOW ENERGY π^--MESON. W.F.Fry, J.Schneps, G.A.Snow and M.S.Swami.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 872-3 (Oct., 1955).

539.18

3260. ON THE DECAYS OF π- AND K-MESONS INTO LIGHT FERMIONS. F.Duimio.
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1308-16 (Dec., 1955). In Italian.

Investigates the possibility of a general scheme of interactions between the elementary particles, by means of a qualitative analysis of some characteristic features of π- and K-decays into light fermions. The conclusions seem to be in agreement with a scheme proposed by Dallaporta and Gell-Mann. A.

539.18

3261. NATURE OF THE NEUTRAL PARTICLES IN THE $K_{\mu 3}$-DECAY. G.Yekutieli, M.F.Kaplon and T.F.Hoang.
Phys. Rev., Vol. 101, No. 1, 506-7 (Jan. 1, 1956).

A K^+-meson has been observed to decay at rest into two minimum ionizing particles and a particle having a grey track. Multiple scattering measurements on the two minimum tracks gave p $\beta = 21 \pm 6$ and 74 ± 9 MeV/c. For minimum tracks these values can only occur for electrons. The other track is identified as a μ^+-meson although the decay electron is not observed. The event is interpreted as the decay of a $K_{\mu 3}$-meson: $K_{\mu 3} \rightarrow \mu^+ + \pi^0 + (\pi^0 \text{ or } \gamma \text{ or } \nu)$; the electron pair arising from the alternative mode of decay of the π^0-meson. If the $K_{\mu 3}$ is a boson the third particle must be a neutrino.
D.J.Prowse

539.18

3262. RADIATIVE AND NONRADIATIVE BOSON DECAY INTO LEPTONS. S.A.Bludman and M.A.Ruderman.
Phys. Rev., Vol. 101, No. 2, 910-11 (Jan. 15, 1956).

The long $K_{\mu 2}$ lifetime and the absence of a K_{e2} mode are explained in terms of the same PV interaction which has been invoked to explain the absence of $\pi \rightarrow e$ decay. The ratio of radiative to non-radiative decay for spin zero mesons is shown to be the same for PS and PV coupling, and to be too small to small to explain the $K_{\mu 3}$ and K_{e3} modes. A differential radiative decay spectrum is given, which holds for the four possible field-coupling combinations and which is essentially that derived from classical radiation damping theory.
R.H.W.Johnston

539.18

3263. BRANCHING RATIO FOR ALTERNATIVE MODES OF DECAY OF HYPERONS AND θ^0 MESONS. G.Takeda.
Phys. Rev., Vol. 101, No. 5, 1547-51 (March 1, 1956).

A study of those restrictions upon the branching ratios of different decay modes of Σ^+, Λ^0 and θ^0 imposed by the invariant property of a system composed of nucleons, pions, hyperons and heavy mesons under the Wigner time reversal. These restrictions give, in fact, upper and lower limits on the various branching ratios. A more or less specific model of

hyperons and θ mesons is used in order to get other possible restrictions on the branching ratios. These results are model-dependent, and subsequently provide a possible test of the model chosen. A.

539.18

3264. DECAY OF THE PI MESON. S.B.Treiman and H.W.Wyld, Jr.
Phys. Rev., Vol. 101, No. 5, 1552-7 (March 1, 1956).

It is known experimentally that, relative to the normal pion decay mode $\pi \rightarrow \mu + \nu$, the branching ratios ρ and ρ_γ for the alternate decay modes $\pi \rightarrow e + \nu$ and $\pi \rightarrow e + \nu + \gamma$ are very small ($\rho, \rho_\gamma \lesssim 5 \times 10^{-5}$). The question is investigated whether these limits on the branching ratios are consistent with the idea that pion decay occurs through a universal Fermi interaction via disintegration into a virtual nucleon pair: $\pi \rightarrow$ virtual nucleon pair $\rightarrow \mu$ (or e) + ν. A value for ρ consistent with the experiments can be obtained if the pseudoscalar coupling constant g_P in the universal Fermi interaction is small compared to the axial vector coupling constant g_A. An estimate of ρ_γ is made assuming that the photodecay occurs through the axial vector coupling, and it is found that there is probably no disagreement with experiment on this score. However, the photodecay can also occur through the tensor interaction (forbidden for $\pi \rightarrow \mu + \nu$ and $\pi \rightarrow e + \nu$). Using the experimental $g_A/g_T \lesssim 0.02$ obtained from beta-decay experiments, gives an estimate $\rho_\gamma \gtrsim 0.025$, a result which is inconsistent with the experimental value. It is shown that the disagreement cannot be removed by using a linear combination of all possible Fermi couplings. An upper limit on g_P for beta decay, valid even in the absence of a universal Fermi interaction, is obtained. A.

539.18

3265. ON THE COMPETITION BETWEEN DECAY AND CAPTURE OF THE UNSTABLE PARTICLES DUE TO THE WEAK INTERACTIONS. S.Ogawa.
Progr. theor. Phys., Vol. 13, No. 4, 367-79 (April, 1955)

In the transmutation processes of unstable particles, some universal interactions seem to be recognized. The competition caused by these interactions between the decay and the nuclear capture of the unstable particles, when they stop in dense material, is examined. The competition is also investigated by the use of assumed interactions in the case where the unstable particle is known to decay into π-mesons, though little is known about the nature of its interactions. It is found that a negatively charged τ-meson, when brought into the K-orbit of a heavy nucleus, is very likely to be absorbed by the nucleus before decaying. It is also noted that there is a certain correlation among the numerical values of the coupling constants of the weak interactions above introduced. A.

539.18

3266. ON THE ORIENTATIONS OF THE PLANES OF DECAY OF DOUBLE V^0-EVENTS. V.M.Kharitonov.
Zh. éksper. teor. Fiz., Vol. 29, No. 6(12), 868-9 (1955). In Russian.

The conclusions of Ballam et al. (Abstr. 3129/1955) about the correlation of these planes were based on a misuse of statistics. G.E.Brown

539.18

3267. THE MEAN LIFETIME AND SOME PROPERTIES OF θ^0-PARTICLES: A CORRECTION TO PREVIOUSLY PUBLISHED DATA. D.B.Gayther.
Phil. Mag., Vol. 46, 1362-4 (Dec., 1955).

The consequences of a numerical error in a previous paper by the author (Abstr. 7759/1954) are elaborated. The corrected θ^0 lifetime is given as $(0.6 \pm {}^{0.4}_{0.2}) \times 10^{-10}$ sec. This when combined with values listed in the previous paper yields a weighted mean $(1.7 \pm {}^{0.7}_{0.4}) \times 10^{-10}$ sec. The conclusions of Gayther and Butler (Abstr. 5652/1955) which depended on the erroneous data are modified and corrected differential energy spectra for Λ^0- and θ^0-particles are given. Allowing for detection bias it is now concluded that probably more Λ^0 than θ^0 are produced in interactions in lead. It is suggested that κ^--capture may account for the Λ^0 excess. R.H.W.Johnston.

539.18

3268. MEAN LIFE OF K^+ MESONS. V.Fitch and R.Motley.
Phys. Rev., Vol. 101, No. 1, 496-8 (Jan. 1, 1956).

K^+ mesons of 465 MeV/c momentum, produced in a Cu target at 60° to the Brookhaven cosmotron proton beam, were magnetically focused and brought to rest in a counter system. They were distinguished from π-meson background by Cherenkov coincidence ($0.62 < \beta < 0.78$) and anticoincidence ($\beta > \beta_K$), the π/K ratio being 400/1. An auxiliary counter system picked out the decay schemes $K_{\mu 2}$ and $K_{\pi 2}$ by imposing "range" and "charged secondary + gamma-conversion" requirements respectively, displaying the delay-times on an oscilloscope. A modification of the system is required for each scheme. The mean lifetimes are given as:

$$\tau(K_{\pi 2}) = (12.1\ {}^{+1.1}_{-1.0}) \times 10^{-9} \text{ sec};$$

$$\tau(K_{\mu 2}) = (11.7\ {}^{+0.8}_{-0.7}) \times 10^{-9} \text{ sec}.$$

The apparatus is sensitive to K_{e3} but not to τ or τ'. R.H.W.Johnston

539.18

3269. LIFETIME OF K MESONS. L.W.Alvarez, F.S.Crawford, M.L.Good and M.L.Stevenson.
Phys. Rev., Vol. 101, No. 1, 503-5 (Jan. 1, 1956).

K-mesons of 340-400 MeV/c momentum produced at right angles to the Berkeley Bevatron proton beam were magnetically focused and brought to rest in a counter system. π-mesons were excluded by requiring a Cherenkov anticoincidence. The π/K ratio was 40/1. An auxiliary counter system simultaneously picked out the decay modes $K_{\mu 2}$ and $K_{\pi 2}$, by imposing "range" and "charged secondary + gamma-conversion" requirements respectively, displaying the delay-times on an oscilloscope. The results are given as: $\tau(K_{\mu 2}) = (1.4 \pm 0.2) \times 10^{-8}$; $\tau(K_{\pi 2}) = (1.3 \pm 0.2) \times 10^{-8}$ sec. -mesons are capable of being detected, but results are inconclusive as yet. R.H.W.Johnston

539.18

3270. ON THE MASSES AND MODES OF DECAY OF HEAVY MESONS PRODUCED BY COSMIC RADIATION. (G-STACK COLLABORATION). J.H.Davies, D.Evans, P.E.Francois, M.W.Friedlander, R.Hillier, P.Iredale, D.Keefe, M.G.K.Menon, D.H.Perkins, C.F.Powell, J.Bøggild, N.Brene, P.H.Fowler, J.Hooper, W.C.G.Ortel, M.Scharff, L.Crane, R.H.W.Johnston, C.O'Ceallaigh, F.Anderson, G.Lawlor, T.E.Nevin, G.Alvial, A.Bonetti, M.di Corato, C.Dilworth, R.L.Setti, A.Milone, G.Occhialini, L.Scarsi, G.Tomasini, M.Ceccarelli, M.Grilli, M.Merlin, G.Salandin and B.Sechi.
Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 1063-1103 (Nov., 1955).

A large emulsion stack, exposed at high altitude, has bee used to study the decay-modes of K-particles which produce a single charged secondary. The 5 decay modes, K_μ χ, κ, K_β and τ' have been recognized from the nature and energy of the charged secondary. The masses of the parent particles of the two-body decay modes, K_μ and χ found from the mean range of the charged secondary are $(976 \pm 7)\ m_e$ and $(969 \pm 3)\ m_e$ respectively. Independent values derived from measurements of the scattering of the secondary track near the decay point are $(954 \pm 17)\ m_e$ and $(972 \pm 15)\ m_e$ respectively. The reliability of these mass values is discussed. An examination of the relative frequency of the decay modes in these experimental conditions indicates that the K_μ and χ-modes constitute respectively about 67% and 20% of all the K-particle decays: the K_{β}, κ- and τ'-modes being present to about 9%, 3% and 1% respectively. A

539.18

3271. $K^+ - \tau^+$ MASS DIFFERENCE. S.Fung, A.Pevsner, D.Ritson and N.Mohler.
Phys. Rev., Vol. 101, No. 1, 493-4 (Jan. 1, 1956).

An area scan for K-mesons in emulsion exposed to the 16-340 MeV/c momentum channel of the Berkeley Bevatron yielded 743 K^+ and 65 τ^+. The composition of the K^+ mixture is known from a separate experiment (to be published) to be 3% $K_{\mu 2}$ and 34% $K_{\pi 2}$. The mean mass difference $m_{\tau^+} - m_{K^+}$ is given as $(4 \pm 4)\ m_e$. By comparison with the proton ranges the absolute mass of the K^+ is given as $965 \pm 4\ m_e$, using the range-energy relations of Barkas. R.H.W.Johnston

539.18

3272. ON THE ANOMALOUS MAGNETIC MOMENT OF THE μ-MESON. G.N.Fowler.
Nuclear Physics, Vol. 1, No. 2, 125-32 (1956).

A discussion is given of various phenomena involving μ-mesons, especially bremsstrahlung and pair production, in which an anomalous magnetic moment of the meson should be important, taking into account finite meson size effects in a relativistic way. It is found that the empirical evidence rules out the existence of an anomalous magnetic moment of any significance for the μ-meson. A.

539.18 : 530.145

3273. ON THE ANOMALOUS SCATTERING OF μ-MESONS. G.N.Fowler.
Nuclear Physics, Vol. 1, No. 2, 119-24 (1956).

The inelastic scattering of μ-mesons with excitation of the "giant" nuclear dipole resonance and its influence on the large-angle scattering of μ-mesons are discussed. It is concluded that the Williams virtual photon method in its original form is not applicable to problems of this kind and that the excitation of "giant" dipole resonances is unable to explain the observed large-angle scattering. A.

539.18

3274. DIFFUSION CHAMBER STUDY OF VERY SLOW MESONS. III. SCATTERING OF NEGATIVE PIONS IN HYDROGEN. M.C.Rinehart, K.C.Rogers and L.M.Lederman.
Phys. Rev., Vol. 100, No. 3, 883-5 (Nov. 1, 1955).

For Pt II, see Abstr. 9955 (1955). The elastic scattering in hydrogen of negative pions near 15 MeV is studied. In a path length represented by 8300 π-μ decays, twenty-six events were observed. At these low energies, the S-wave dominates the scattering. Treating the small P-wave and large Coulomb contributions as known, the data is found to be well represented by an S-wave phase-shift proportional to momentum. Under this assumption, the phase-shift parameters are given by the relation: $\alpha_3 + 2\alpha_1 = (0.25 \pm 0.04)\ p/\mu c$ in radians, A.

539.18

3275. ELASTIC SCATTERING OF POSITIVE AND NEGATIVE PIONS ON ALUMINUM. A.Pevsner, J.Rainwater, R.E.Williams and S.J.Lindenbaum.
Phys. Rev., Vol. 100, No. 5, 1419-31 (Dec. 1, 1955).

The elastic, plus nearly elastic, scattering of 80 MeV π^+ and π^- mesons on aluminium was measured as a function of scattering angle. The results are compared with optical model phase-shift calculations using a uniform nuclear model with $R = 1.42A^{1/3} \times 10^{-13}$ cm and various choices of constant complex potential $V = V_1 + iV_2$ inside the nucleus. The experimental curves demonstrate clearly the destructive interference between nuclear and Coulomb scattering for π^+ mesons, and the corresponding constructive interference for π^- mesons, near 20°. The experimental curves do not show the diffraction minima present in the theoretical curves, and show a slow increase in the differential cross-section beyond beyond 90°. To the extent that the experimental curves for $\theta \lesssim 50^\circ$ can be compared with experiment, the best fitting values of V_1 and V_2 are $V_1 = -20$ MeV for π^+ and -30 MeV for π^-, corresponding to -25 MeV for nuclear effects alone, and $V_2 \simeq -20$ MeV in each case. A value $\lambda_a \simeq 4 \times 10^{-13}$ cm is favoured for this theoretical model used for comparison with experiment. The potential V was treated as the fourth component of a four vector in a Klein–Gordon-type wave equation in analogy with the Coulomb interaction. A.

539.18

3276. PHASE-SHIFT OPTICAL MODEL CALCULATIONS FOR THE ELASTIC SCATTERING OF PIONS ON ALUMINUM. A.Pevsner and J.Rainwater.
Phys. Rev., Vol. 100, No. 5, 1431-9 (Dec. 1, 1955).

Theoretical optical-model exact phase-shift calculations are given for the predicted elastic scattering of pions from aluminium at the energy used (79 MeV) in the experimental studies described in the preceding abstract. The predicted curves show strong diffraction minima, not present in the experimental curves. A comparison is made of the results of these calculations with those of more approximate methods. Sixteen choices of constant complex potentials were used for $r < R_0$ for both π^+ and π^- mesons, with a Coulomb potential for $r > R_0 = 3.600\lambda\!\!\!^{-}$. Here $\hbar k_0 = \hbar/\lambda\!\!\!^{-}$ is the momentum at infinity and $\hbar(k_1 + ik_2)$ is the momentum for $r < R_0$. It is found that the predicted incoherent cross-section σ_a and positions of the diffraction minima depend strongly on k_1/k_0 for a fixed k_2. Values of $\sigma_a > \pi R_0^2$ are obtained for relatively long nuclear mean free paths $(2k_2)^{-1}$ for incoherent processes for the attractive potentials which give best fit to experiment. The results of various modified Born approximation calculations are compared with the results of the exact calculations. A.

539.18

3277. PION-NUCLEON SCATTERING CALCULATIONS IN THE TAMM-DANCOFF THEORY. M.H.Kalos and R.H.Dalitz.
Phys. Rev., Vol. 100, No. 5, 1515-22 (Dec. 1, 1955).

For the S, P and D states (except those with $j = T = 1/2$), phase shifts and wave-functions have been calculated numerically for pion energies up to about 1 BeV, on the basis of the simplest Tamm–Dancoff integral equation for pseudoscalar pion theory both (a) including and (b) omitting the pair transitions. In the numerical treatment, special attention was paid to the various singularities of these integral equations. For the (3,3) state, a very sharp resonance is obtained for case (a) with $G^2/4\pi = 15.5$ and a good fit to the (3,3) phase shift for energies up to 300 MeV, above which the phase shift lies below the experimental value. For case (b), a coupling constant $G^2/4\pi = 30$ was needed for a fit to the low energy (3,3) phase shifts and δ_{33} then reaches resonance only at very high energies, if at all. Other phase shifts for case (a) are in general accord with those of Dyson et al. A.

539.18

3278. TOTAL CROSS SECTIONS FOR SCATTERING AND ABSORPTION OF PIONS BY NUCLEI. R.M.Sternheimer.
Phys. Rev., Vol. 101, No. 1, 384-7 (Jan. 1, 1956).

The causality conditions of Goldberger for the pion-nucleon scattering have been used to calculate the parameter k_1 of the optical model for scattering of pions from nuclei. These values of k_1 together with values of the absorption coefficient K in nuclear matter were used to obtain the total absorption and diffraction cross-sections of pions for carbon, copper and lead in the range 0-2.5 BeV. A.

539.18

3279. 78-MeV $\pi^\pm$ MESON SCATTERING FROM LITHIUM. R.Williams, J.Rainwater and A.Pevsner.
Phys. Rev., Vol. 101, No. 1, 412-18 (Jan. 1, 1956).

The angular distributions of 78 MeV $\pi^\pm$ mesons scattered elastically from lithium have been measured. The distributions have been analysed by combining coherently the scattering amplitudes for the individual pion-nucleon interactions, and weighting each amplitude by a form factor determining the ability of the struck nucleon to absorb the momentum recoil

and remain in its same state in a nuclear harmonic oscillator well. Corrections are applied for solid angle transformations between the pion-nucleus and pion-nucleon centre-of-mass systems, the effect of the required nuclear elastic scattering upon the available phase space in the pion-nucleon system, and an initial momentum distribution for the nucleons. The simple Born approximation treatment provides agreement with the pronounced dip at 75° and the backward rise of the experimental curves. A.

539.18

3280. SCATTERING OF 217-MeV POSITIVE PIONS ON HYDROGEN. H.D.Taft.
Phys. Rev., Vol. 101, No. 3, 1116-27 (Feb. 1, 1956).

The total and differential cross-section for the scattering of 217 MeV positive pions on hydrogen has been measured in nuclear emulsions. The total cross-section, excepting Coulomb scattering, was found to be (151.0 ± 18.2) mb. The angular distribution in the centre of mass was fitted by $d\sigma/d\Omega = (5.22 \pm 1.42) + (7.53 \pm 2.57) \cos\chi + (20.36 \pm 4.61)\cos^2\chi$ mb/steradian, assuming S and P waves only. A phase-shift analysis was carried out using the method of maximum likelihood. The phase-shift solution in agreement with the requirements of causality and corresponding to the preferred solution of de Hoffman et al. was $\alpha_3 = -22.5^\circ \pm 5.8^\circ$, $\alpha_{33} = 114.0^\circ \pm 7.4^\circ$, and $\alpha_{31} = -11.6^\circ \pm 9.7^\circ$. The angular distribution showed strong forward scattering and a preference for positive Coulomb interference, in agreement with the hypothesis of a resonance in the state with angular momentum $\frac{3}{2}$ and isotopic spin $\frac{3}{2}$ A.

539.18

3281. INELASTIC SCATTERING OF MESONS IN A SEMI-PHENOMENOLOGICAL THEORY OF INTERACTION OF π-MESONS WITH NUCLEONS. Yu.M.Popov and A.A.Rukhadze.
Zh. éksper. teor. Fiz., Vol. 29, No. 6(12), 893 (1955). In Russian.

The state of nucleon plus two mesons is included in the theory of Tamm et al. (Abstr. 1243/1955). Agreement with experiment is good for π^+-mesons on protons, but the theoretical answer is too low for π^--mesons on protons. G.E.Brown

539.18

3282. ON THE WEAK INTERACTIONS OF HYPERONS AND HEAVY MESONS. B d'Espagnat and J.Prentki.
C.R. Acad. Sci. (Paris), Vol. 242, No. 6, 740-2 (Feb. 6, 1956). In French.

To obtain the selection rules $\Delta I = \pm\frac{1}{2}$, $\Delta S = \pm 1$, (for isotopic spin and strangeness respectively), it is required that for a weak interaction the interaction Hamiltonian is a component of an isospinor. Some specific predictions of the resultant theory are discussed. J.S.Bell

539.18

3283. EVIDENCE FOR NUCLEAR INTERACTION OF A CHARGED HYPERON IN FLIGHT. R.D.Hill, F.T.Gardner and J.E.Crew.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 824-7 (Oct., 1955).

A Σ^- hyperon, arising from a 12 + 0p star, disappears in flight, presumably by interacting with a proton and producing a neutral hyperon and neutron. A.

539.18

3284. AN EXAMPLE OF THE ASSOCIATED PRODUCTION OF A HEAVY MESON AND A HYPERON. P.H.Fowler and W.C.G.Ortel.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 864 (Oct., 1955).

Among the secondary particles of a large star have been found a heavy meson decaying in the K_μ mode and a hyperon decaying in the Σ mode. J.S.Bell

539.18

3285. NUCLEAR PRODUCTION OF HEAVY UNSTABLE PARTICLES. M.M.Block and R.Jastrow.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 865-8 (Oct., 1955).

Monte Carlo calculations have been made, taking account of the interaction of the heavy particles with the nucleus before their emergence. To obtain agreement with experiment the reaction $K + N \rightarrow Y + \pi$ (forbidden by Gell-Mann and Pais) might be required, but this is not certain. J.S.Bell

539.18

3286. THE ASSOCIATED PRODUCTION OF A χ-MESON AND A Σ-PARTICLE IN A NUCLEAR DISINTEGRATION. P.H.Fowler and D.H.Perkins.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 874-5 (Oct., 1955).

For preliminary report see Abstr. 7385 (1955). During a systematic mass analysis of fast particles emerging from cosmic-ray showers in emulsions an example was observed of a χ-meson produced in association with a Σ-particle. The parent star was of type 18 + 20α. The K-meson came to rest after 3.61 cm and decays into a particle which travels 3.9 cm before leaving the stack. Scattering and grain-density measurements yield a mass value of 295 ± 30 m_e. It is hence identified as a π-meson, making the K-meson a χ. The hyperon decays in flight after travelling 217μ. The secondary is identified as a π^--meson and energy measurements are consistent with a Σ^--decay. The dynamics of the event are inconsistent with the $\pi + N \rightarrow Y + K$ mode of production, a nucleonic collision being necessary. In view of the suspected difference in spin between the χ and the τ-meson, it is perhaps strange that both have been observed in association with a Σ^--particle. D.J.Prowse

539.18

3287. ON THE PRODUCTION OF MESONS IN HYDROGEN AND CARBON ABOVE 10 GeV. Y.Watase, K.Suga, Y.Tanaka and S.Mitani.
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1183-201 (Dec., 19

Penetrating showers from hydrogen and carbon (average energy about 30 GeV) have been studied by CH_2-C subtraction method with a counter hodoscope at mountain altitude. The cross-section for meson production in hydrogen was found to be 67 ± 25 mb and that for multiple production appears to be at least about 70% of this value. No difference in the cross-sections for p-p and n-p collisions was observed. The angular distribution of the charged shower secondaries seems to show a forward peak in the p-p collisions and this tendency may be interpreted by the hypothesis that the incident nucleon is emitted into a rather sharp forward cone in the centre-of-mass system, at least when the multiplicity is small. A

539.18

3288. ON THE PRODUCTION OF π-MESONS IN HEAVY NUCLEI BY THE ACTION OF ENERGETIC PRIMARY NUCLEONS. G.Costa and G.Lanza.
Nuovo Cimento (Ser. 10), Vol. 2, No. 6, 1211-22 (Dec., 1955). In Italian.

The production of π-mesons in Al, Ag and Pb has been studied, assuming the independent particle nuclear model, and treating the behaviour of the pions in the nuclei, as a succession of single collisions, from their creation, at any point of a nucleus, till their coming out or their absorption. Total and differential scattering cross-sections were used, partly derived from the big machines data, and partly deduced by the charge-independence principle and the detailed balancing method. Owing to the scarcity of precise data on the absorption cross-section three different curves were assumed for it. Owing to the complexity of the phenomena, a Montecarlo calculation was made, building two series of three-dimensional models, for pions with an initial energy of 100 and of 200 MeV (energy at the creation inside the nucleus). The lack of precise indications on the pion production spectrum, makes the result (which should be averaged over it) not directly comparable with experimental data, except those which are found to be sufficiently independent of the initial energy. This is the case for the total production cross-section of the pions, which

ncreases with the atomic number and shows a tendency to aturation, and of the angular distributions, which indicate a naximum in the forward direction and another between about 00 and 120 degrees. No one of these results seems to be ependent in a sensible way on the type of assumed absorption. A.

539.18

289. MESON PRODUCTION IN NUCLEON-NUCLEON COLLISIONS AT HIGH ENERGIES. J.S.Kovacs.
Phys. Rev., Vol. 101, No. 1, 397-409 (Jan. 1, 1956).

Calculations based on a statistical model have yielded esults concerning the relative probabilities for the different nultiplicities and charge distribution of mesons produced in ucleon-nucleon collisions. In deviating from a pure statistical nodel the important effects of final state interactions and arious selection rules have been included, using results of neson-nucleon scattering experiments. Notably in the results he suppression of some one-meson final states by considera- ion of the Pauli principle and conservation of angular momen- um and parity, along with the enhancement of two-meson tates due to resonance effects, have brought about results vhich are in closer agreement with experiment than predic- ions of a pure statistical nature. Account was taken of the final tate interactions by considering separately the nucleon-nucleon interactions and meson-nucleon interactions, a separation made plausible by consideration of the small amount of kinetic energy taken away by the more massive particles. Meson-meson interactions were neglected. The nucleon-nucleon interaction was taken care of by introducing in the statistical weight a factor which is the square of the wave-function for the scattering of two nucleons evaluated at the origin of their interaction. The meson-nucleon final state scattering was treated by the method discussed by Chew, modified for the case of a meson scattering off two sta- tionary and superposed nucleons. Multiplicities up to two mesons were considered. On comparing with experimental results, at 1.7 BeV bombarding energy of neutrons on protons the ratio of the probability of occurrence of the final states (np+ −): (pp - 0): pp -) is calculated to be 3.0 : 1.0 : 0.9, while experiment gives 3.3 : 1 : 0.8. The ratio of the total probability for double meson production to that for single meson production at this energy s 1.2, while a modifi ed result of observations gives 1.4. Results on proton-proton collisions do not yield good agree- ment with present observations. A.

539.18

3290. MULTIPLE PION PRODUCTION IN n—p COLLISIONS AT THE BEVATRON. W.B.Fowler, G.Maenchen, V.M.Powell, G.Saphir and R.W.Wright.
Phys. Rev., Vol. 101, No. 2, 911-13 (Jan. 15, 1956).

π-producing collisions by 0.28-6.2 BeV neutrons are studied using a hydrogen-filled diffusion chamber in a pulsed magnetic field. One 7-prong event is attributed to production of 5 or possibly 6 π-mesons. 48 five- and 473 three-prong events are observed. Preliminary work suggests that 16 of the 5-prong events have one or more neutral particles and that 3 have no neutral particles, the remainder being indeter- minate. The available centre of mass energy extended up to 2 BeV. R.H.W.Johnston

539.18

291. MODEL FOR MULTIPLE MESON PRODUCTION. E.M.Henley and T.D.Lee.
Phys. Rev., Vol. 101, No. 5, 1536-47 (March 1, 1956).

A model is presented for the multiple production of mesons. It is similar to that of Lewis, Oppenheimer, and Wouthuysen, but treats the spins and isotopic spins of the colliding nucleons as quantum mechanical operators. To illus- trate the method, detailed calculations are carried out for a symmetrical scalar meson theory. A.

539.18

292. ON FERMI'S THEORY OF MULTIPLE PRODUCTION. K.Ono and K.Yokoi.
Progr. theor. Phys., Vol. 13, No. 1, 101-2 (Jan., 1955).

A simplified thermodynamic approximation (no nucleon pair creation, no charge, spin and angular momentum con- servation) leads to the result $N \propto E^{2/3}$, where N is the number of emitted mesons ($\gg 1$), and E the total energy of the system. G.Field

539.18

3293. PRODUCTION OF A μ-MESON PAIR ON ANNIHILATION OF POSITRONIUM. V.B.Berestetskiĭ and I.Ya.Pomeranchuk.
Zh. éksper teor. Fiz., Vol. 29, No. 6(12), 864 (1955). In Russian.

A positron of energy greater than 4×10^{10} eV impinging on an elcctron can form a μ-meson pair, with a probability about 70 times less than the probability of two-photon annihilation. G.E.Brown

539.18

3294. PRODUCTION OF NEUTRAL π-MESONS IN n-p COLLISIONS AT EFFECTIVE NEUTRON ENERGY OF 590 MeV. V.P.Dzhelepov, K.O.Oganesyan and V.B.Flyagin.
Zh. éksper. teor. Fiz., Vol. 29, No. 6(12), 886-9 (1955). In Russian.

Gamma-rays from the decay of π^0-mesons are detected by a telescope of two scintillation and one Cherenkov counters The cross-sections for protons are obtained by subtraction from the results for polyethylene and graphite. Absolute measurements are obtained by simultaneously measuring the number of γ-rays and of recoil protons from elastic n-p collisions. The cross-section for production of gamma-rays by way of π^0's was found to be $(0.72 \pm 0.18) \times 10^{-27}$ cm^2/ster. G.E.Brown

539.18

3295. ON THE POSSIBILITY OF PRODUCTION OF PENETRATING RADIATION (μ^0-MESONS) IN COLLISIONS OF PROTONS OF HIGH ENERGY WITH NUCLEI.
A.N.Novikov, B.M.Pontekorvo and G.I.Selivanov.
Zh. éksper. teor. Fiz., Vol. 29, No. 6(12), 889-92 (1955). In Russian.

In a theory of interaction of μ-mesons pairs with nucleons (which might explain the anomalous cross-section for scatter- ing of μ-mesons by nuclei) μ^0-mesons would probably be formed. If produced with appreciable probability these would be detected in the experiment described here by means of the charge-exchange reaction $\mu^0 + p \rightarrow \mu^+ + n$, after which the μ^+-meson would be detected. No effect is observed; therefore an upper limit can be put on the formation of a μ-meson pair, one member of which is a μ^0, in nucleon—nucleon collisions of about 7×10^{-31} cm^2 under certain assumptions about the angular distribution, etc. G.E.Brown

539.185

3296. A METHOD OF MEASURING THE CAPTURE TIME OF NEUTRONS FROM A Po—Be SOURCE IN HYDROGENOUS SUBSTANCES. P.Dietrich.
Z. Phys., Vol. 144, No. 1-3, 108-19 (1956). In German.

Gamma-ray quanta emitted from a Po—Be source at the same time as the neutrons from the $Be^9_4(\alpha, n)$ reaction are brought into delayed coincidence with the combination quanta from the p—n capture reaction. By measuring the delay the capture time for the neutrons in various substances can be deduced. D.J.Prowse

539.185

3297. A THEORETICAL STUDY OF THE TIME ENERGY DISTRIBUTION OF SLOWED-DOWN NEUTRONS. O.Olsson.
Ark. Fys., Vol. 10, Paper 12, 129-44 (1955).

The slowing-down of neutrons by elastic impacts against free atoms at rest is considered. Absorption is neglected. The integro-differential equation of the problem is Laplace

transformed with respect to the time, t, and the logarithmic energy variable, u. In Pt I the scattering mean free path, l, of the neutrons is assumed to be proportional to the velocity. An asymptotic formula, giving the time energy distribution for large values of u, is derived by means of the saddle point method. In Pt II, l is assumed to be constant. A solution, giving a certain insight into the statistical structure of the distribution function, is studied. A.

539.185

3298. THE DIFFUSION OF NEUTRONS THROUGH A PLATE. M.Feix and S.Valentin.
C.R. Acad. Sci. (Paris), Vol. 242, No. 5, 617-20 (Jan. 30, 1956). In French.

A matrix solution of the integral diffusion equation is obtained after imposing the conditions that the scattering is assumed isotropic and that the effective cross-section is constant for each successive collision. The reflection and transmission coefficients are calculated for a beam falling normally on the plate. The results are in reasonable agreement with a Monte-Carlo type calculation. J.Hughes

539.185

3299. THE INFLUENCE OF HINDERED ROTATION ON THE SCATTERING OF SLOW NEUTRONS BY BOUND PROTONS. II. W.Kołos.
Acta phys. Polon., Vol. 14, No. 3, 173-82 (1955).

For Pt I, see Abstr. 6929 (1954). The influence of rotation of a rigid molecule on the cross-section of a proton bound in the molecule is considered. The molecule is assumed to be a symmetric rotator. Using the "static approximation" of Placzek, contributions to the cross-section due to various changes of the rotation about the axis of symmetry are calculated. It was shown in Pt I that this enables the influence of hindered rotation on the proton cross-section to be calculated for collisions elastic with respect to the hindered rotation. The method is applied to the methyl alcohol molecule. It is shown that the influence of hindered rotation makes the cross-section of the molecule about 13% smaller compared to that of the molecule assumed to be rigid. A rough estimate shows that the remaining experimentally observed effect may be due to vibrations of the protons. A.

539.185

3300. DYNAMICS OF NEUTRON SCATTERING BY MOLECULES. A.C.Zemach and R.J.Glauber.
Phys. Rev., Vol. 101, No. 1, 118-29 (Jan. 1, 1956).

The scattering of low-energy neutrons by molecules is investigated by a method which facilitates the treatment of inelastic processes. Dynamical systems characterized by the degrees of freedom of gas molecules are examined in detail. The formalism is applied first to the derivation of the differential cross-section for scattering by an ensemble of coupled harmonically oscillating nuclei in thermal equilibrium. Rotator scattering is investigated in the limits of high and low energy, and inelastic corrections to the static approximation are also calculated. The cross-section of a thermally excited monatomic gas is presented in a closed form which shows its dependence on the ratio of the mean velocity of thermal motion to the neutron velocity. Results appropriate to large and to small values of the velocity ratio are derived. Quantitative estimates for the validity of the various approximations are given. A.

539.185

3301. NEUTRON DIFFRACTION BY GASES. A.C.Zemach and R.J.Glauber.
Phys. Rev., Vol. 101, No. 1, 129-36 (Jan. 1, 1956).

The methods developed in the preceding abstract for the treatment of neutron scattering by simplified molecular models are extended to form a unified description of scattering by real molecules. The generalization takes into account the influence on scattering of the interactions that appear among the different molecular degrees of freedom. The effect of spin correlations within molecules due to symmetries occurring in the presence of like nuclei is explicitly determined. The slow-neutron cross-section of methane is calculated and compared with experiment. A.

539.185

3302. BOUND STATES AND LOW-ENERGY NEUTRON SCATTERING. R.D.Lawson.
Phys. Rev., Vol. 101, No. 1, 311-13 (Jan. 1, 1956).

Solutions are given for the S states of the potential $V(r) = -V_0/[1 + e^{\alpha(r-a)}]$. These are used to calculate the position of the giant S-wave neutron resonances at low (zero) energy and the bound states of the potential. If one chooses $V_0 = 39.8$ MeV $\alpha = 2 \times 10^{13}$ cm^{-1} and $a = 1.35A^{1/3} \times 10^{-13}$ cm, the potential binds the right number of particles. S-wave maxima in the elastic scattering cross-sections then occur at A = 13, 64 and 183. The experimental curves show a rise in the total scattering cross-section in the region A ~ 60 and 180 for small neutron energies. A.

539.185.0

3303. OPERATING A HURST-TYPE FAST-NEUTRON DOSIMETER IN HIGH GAMMA FIELDS. J.T.Bracken, E.A.Rollor and J.A.Mohrbacher.
Nucleonics, Vol. 13, No. 10, 70-3 (Oct., 1955).

The presence of a high gamma-radiation background in a homogeneous type methane-polythene proportional neutron counter leads to an increase of pulse heights due to neutron-gamma coincidences and a decrease due to positive ion shielding of the collector wire. The former effect predominates in the smaller pulses and the latter in the larger pulses. A higher operating potential increases the shielding effect. By means of a correct choice of operating potential and bias voltage, it is possible to make the two effects compensate. Results obtained with Po-Be neutrons in different gamma-radiation fields are described. L.R.Shepherd

STRUCTURE OF SOLIDS 539.2

539.217

3304. THERMAL DIFFUSION IN SINGLE CRYSTALS OF ZINC. F.R.Winter and H.G.Drickamer.
J. chem. Phys., Vol. 24, No. 2, 492-3 (Feb., 1956).

Measurements have been made both perpendicular and parallel to the C-axis using traces of Tl^{204}, Ag^{110}, and In^{114} impurities. A concentration gradient is produced by maintaining a temperature gradient of 45° C. The separation factors (thermal diffusion ratios) are determined and an expression for this factor involving the activation energies for motion is derived. W.Bardsley

539.221 : 537.312.5

3305. A STUDY OF THE STRUCTURE OF ABRADED METAL SURFACES. L.Grunberg and K.H.R.Wright.
Proc. Roy. Soc. A, Vol. 232, 403-23 (Nov. 8, 1955).

Kramer and other workers have found that freshly abraded metal surfaces produced counts when placed beneath open Geiger-Müller tubes. It has also been shown that such surfaces give photoelectrons at wavelengths longer than the photoelectric threshold of the metal. The latter effect was investigated in the present work. The emission at different ranges of wavelength was studied for a number of freshly abraded metals. All the metals investigated give emission in the range 3000 to 3700 A, while aluminium, magnesium and zinc gave emission also in the visible range. A strong emission peak was found at 4700 A (2.64 eV) and a smaller peak at about 5200 A. A broad band at 6000 to 7000 A was also found to be present. The emission current increased as the square of the negative

potential applied to the specimen, so that the "activity" of a specimen, α, could be defined as counts $min^{-1} V^{-2}$. The emission current also increased with the intensity of illumination. The decay of the emission peak at 4700 A from abraded aluminium was studied in detail. When the specimen was kept in an inert atmosphere (argon), and in darkness, the decay followed the equation for a first-order reaction with a rate constant $k_1 = 1.5 \times 10^{-5}$ sec^{-1}. Continuous illumination and flow of emission current increased the rate of decay. Unfiltered high-intensity illumination caused temporary fatigue of the emissive properties. When specimens were kept in atmospheres containing oxygen, decay was more rapid. The decay in the presence of oxygen was found to follow the equation $\alpha_t = \alpha_0/(1 + k_2 t)^2$, where α_t denotes the activity, α_0 the initial activity, t the time and k_2 a rate constant which increased proportionally with the concentration of oxygen in the gas. The distribution of the activity in depth was investigated, and it was found that when an outermost "dead" layer had been removed by etching, a layer of high activity was encountered, which extended to 5 to 10 microns below the surface. The suggestion by other workers that the emissive properties derived from the metal and depended on exothermal processes was found untenable. Emission in the visible range, observed with metals which give "excess-metal" oxides, is due to lattice imperfections in the oxide. The peak at 4700 A is thought to be due to excited F'-centres (oxygen ion vacancies occupied by two electrons) which, when returning to the ground state, cause emission from shallow centres near the surface. The nature of the structures responsible for the other peaks and bands is yet uncertain. A.

539.23

3306. STRESS ANNEALING IN COPPER FILMS. R.W.Hoffman and H.S.Story.
J. appl. Phys., Vol. 27, No. 2, 193 (Feb., 1956).

A brief description is given of a method with which the stress in Cu films (900-1500 A thick) has been measured at temperatures between −150 and +75°C. The changes are similar to those found with Ni, except that they occur at lower temperatures. R.A.Weale

539.232 : 535.323 : 535.417

3307. ON THE THICKNESS AND THE DISPERSION OF THE REFRACTIVE INDEX OF THIN ALUMINIUM OXIDE LAYERS. M.Hennig.
Z. Phys., Vol. 144, No. 1-3, 296-310 (1956). In German.

The dependence of the thickness of the layer of aluminium oxide films on the oxidation voltage is studied interferometrically. Measurements are made for different ammonium citrate concentrations. The relation is found between the film thickness and the formation voltage. The refractive index measurements are made for different wavelengths. The refractive index in the range 3600 to 6500 A increases from 1.577 to 1.560. In the region 4360 A a dispersion anomaly is established. S.Tolansky

539.234

3308. SURFACE AREA AND PARTICLE SIZE OF EVAPORATED LEAD SULFIDE FILMS. R.H.Harada.
J. chem. Phys., Vol. 24, No. 2, 447-52 (Feb., 1956).

Physical adsorption isotherms of lead sulphide films evaporated in vacuum and through oxygen were measured in order to determine their surface area and particle size. The surface areas of fresh and of annealed vacuum evaporated films were found to increase linearly with film thickness. Annealing the films in vacuum decreased the surface area considerably. The average specific surfaces of the fresh and annealed films were 63 m^2/g and 6 m^2/g, corresponding to particle sizes of 0.013 micron and 0.13 micron, respectively. The surface area of fresh films evaporated through oxygen depended upon the rate of evaporation. The average specific surface of the fresh slowly evaporated films was 66 m^2/g; for those evaporated faster, it was 118 m^2/g. The corresponding particle sizes were 0.012 micron and 0.0068 micron. When these films were annealed in a closed vacuum system, the specific surface became 12 m^2/g and 14 m^2/g, corresponding to particle sizes of 0.067 micron and 0.056 micron, respectively. For films evaporated through oxygen, the oxygen is chemisorbed on the surface of the film during vaporation. When such a film is annealed sulphur dioxide is evolved and sulphate is formed. A.

539.26/27

3309. THE EQUIVALENCE OF ELECTRON-MICROSCOPE AND X-RAY OBSERVATIONS ON COLLAGEN FIBRES. R.E.Burge and J.T.Randall.
Proc. Roy. Soc. A, Vol. 233, 1-16 (Dec. 6, 1955).

One of the outstanding properties of collagen fibrils is an axial periodicity of about 640 A and associated fine structure which can be observed directly in the electron microscope and also may be deduced from observation of low-angle X-ray diffraction. This paper gives first an account of measurements of density fluctuations along the fibril axis for unstained, unshadowed fibrils for one mammalian collagen, rat-tail tendon, and one avian collagen, fowl-neck tendon. The main and subsequent part of the paper shows how the density functions derived from electron micrographs obtained under specified conditions may be used to calculate the intensities of low-angle X-ray diffraction. Complications arise from the fact — of considerable biological interest — that for any one material a wide range of fine structure exists. For this reason it has been necessary to introduce a modulating function to represent the behaviour of a system of fibrils with differing density functions. The calculated structure amplitudes are compared with those measured from low-angle X-ray photographs of dry fibres. Good agreement between the two sets of results is found for rat-tail tendon and fair agreement for fowl-neck tendon. The agreement for fowl-neck tendon is improved by the application of a more general modulating function. A.

539.26 : 539.234

3310. AN X-RAY STUDY IN HIGH VACUUM OF THE STRUCTURE OF EVAPORATED COPPER FILMS. H.D.Keith.
Proc. Phys. Soc. B, Vol. 69, Pt 2, 180-92 (Feb., 1956).

Films of metallic copper which have been deposited on a glass substrate at −183°C in a high vacuum to a thickness of 2000 A are shown to consist of aggregates of randomly oriented microcrystallites of nominal size 40 A, this dimension being reproducible and almost independent of the nature of the substrate at this temperature. If the films are annealed to room temperature in a vacuum which precludes the chemisorption of oxygen or other reactive gas, there is a large, rapid and irreversible increase in the nominal particle size to at least 400 A. The chemisorption of a saturated monolayer of oxygen at −183°C before the annealing takes place, however, almost completely prevents this re-crystallization and the particles grow to only 60 A. The corresponding chemisorption of a smaller quantity of oxygen, sufficient only to give a small but appreciable fraction of a monolayer, inhibits the annealing process and can prolong it for several days. It does not, however, prevent the film from re-crystallizing to almost the same extent as in the complete absence of oxygen. These results are shown to be in qualitative agreement with resistivity and gas adsorption data for copper films, and their bearing on the problem of establishing a model for the structure and behaviour of evaporated metallic films is outlined. The experiments as a whole indicate that surface diffusion plays a leading part in the re-crystallization of the disordered films. Some further experiments on the effect of residual air on the structure of copper films deposited at room temperature are described, and the design of a low temperature high vacuum X-ray focusing camera, which was constructed entirely of glass and used for the above experiments, is also discussed. A.

539.27

3311. ELECTRON DIFFRACTION STUDY OF THIN FILMS OF TITANIUM AND OF THEIR OXIDATION. P.Conjeaud.
J. Rech. Cent. Nat. Rech. Sci., Vol. 6, 273-90 (Sept., 1955). In French.

Films of titanium were condensed in a vacuum on the (001) faces of crystals of NaCl, KCl and KBr. Different experimental conditions, temperature of evaporation and condensation, gave films which were (1) polycrystalline without any preferred orientation, (2) fibrous with the hexagonal Ti $[2\bar{1}\bar{1}0]$ direction parallel to the $[\bar{1}10]$ direction of the salt crystal or (3) monocrystalline with Ti $(0\bar{3}34)$ parallel to salt (001). Oxidation of of the films was carried out under reduced pressure within the electron diffraction apparatus. At 300° C TiO with a face-centred cubic structure was formed. At 400° C the dioxide appeared in two forms, anatase and rutile. Both forms are tetragonal; the predominant component rutile showed preferred orientation. Towards 550° C the anatase disappears and at higher temperatures, up to 800° C, the only stable form is rutile. The formation of the orthorhombic oxide Ti_2O_3 has not yet been observed. J.Iball

539.27 : 539.23

3312. THE STRUCTURE OF THIN OXIDE LAYERS ON MONOCRYSTALLINE LAYERS OF IRON. O.Haase.
Z. Naturforsch., Vol. 11a, No. 1, 46-54 (1956). In German.

Oxide layers have been prepared, by methods which are described, under various conditions of temperature and low pressure, and have been studied by electron diffraction. Generally a layer of Fe_3O_4 was found, with a spinel structure having two of its cube axes making angles of 45° with the cube axes of the iron crystal. A.R.Stokes

539.27 : 539.23

3313. THE ORIENTATION OF THIN EVAPORATED METAL LAYERS. H.Göttsche.
Z. Naturforsch., Vol. 11a, No. 1, 55-68 (Jan., 1956). In German.

An investigation has been carried out by electron diffraction methods of thin layers of the cubic face-centred metals, Ag, Au, Al, Pd and Cu evaporated on to the (100) faces of the alkali-halide crystals, LiF, NaCl, KCl and HI. The evaporation took place under high vacuum conditions and the temperature above which orientation appeared was ascertained. The dependence of this temperature on the relative lattice constants of the metal and halide crystal was studied and other variables were also found to influence the films. Evaporation at room temperature usually gives polycrystalline films but by suitable heat treatment they change into oriented films. A diagram of the apparatus is given. J.Iball

539.27 : 621.385.833

3314. THE SCANNING ELECTRON MICROSCOPE AND ITS FIELDS OF APPLICATION. K.C.A.Smith and C.W.Oatley.
Brit. J. appl. Phys., Vol. 6, No. 11, 391-9 (Nov., 1955).

Experience with the scanning electron microscope has shown that there are fields of application where this instrument has distinct advantages over the conventional transmission microscope (with or without replicas) and the reflection electron microscope. For example, there are specimens which are too thick to be viewed by direct transmission and which nevertheless do not lend themselves readily to the construction of replicas, either because they are too fragile, because their surfaces are undercut so that the replica would be keyed to them or because observation of the specimen at high temperatures is desired. The paper gives examples of the use of the scanning microscope in such cases and shows that the images produced are very similar in character to those obtained with optical microscopes. In particular, a pronounced three-dimensional effect is observed. In the work described the specimens have been mounted so that the mean surface under observation is at a glancing angle of about 25° to the incident electron beam. Contrast is provided by the variation of the local angle of incidence as the scanning electron beam moves over the surface, and does not depend on secondary emission. With the present apparatus a resolution of about 200 A has been attained, but there appears to be no reason why this performance should not be substantially improved. It is shown that, with the scanning microscope, bombardment of the specimen is much less severe than with other electron microscopes. A.

ELASTICITY. STRENGTH. RHEOLOGY 539.3/.9

539.32 : 548.0

3315. EVALUATION OF THE FOUR ELASTIC CONSTANTS OF SOME CUBIC CRYSTALS. C.V.Raman and D.Krishnamurti.
Proc. Indian Acad. Sci. A, Vol. 42, No. 3, 111-29 (Sept., 1955).

The belief that the elastic behaviour of cubic crystals can be described in terms of three constants rests on theoretical considerations which are examined in the paper and shown to be indefensible. The correct theory demands four constants for cubic crystals belonging to the O_h and T_d classes. The experimental results for sixteen different crystals belonging to these classes for which the most precise data are available are critically examined and it is shown that the adiabatic bulk modulus as computed respectively from the observed velocities of ultrasonic wave propagation and from the static determinations of compressibility made at Harvard are in systematic disagreement. The data show very clearly that the elastic behaviour of these crystals cannot be expressed in terms of three constants, but needs four. The latter have been computed and tabulated. A.

539.32 : 548.73

3316. THE STUDY OF THE ELASTIC CONSTANTS OF WHITE TIN BY DIFFUSE X-RAY REFLEXION. S.C.Prasad and W.A.Wooster.
Acta cryst., Vol. 8, Pt 11, 682-6 (Nov., 1955).

Tin crystals were grown by lowering a tube containing the melt through a vertical furnace, at a rate of 5 mm.hr.$^{-1}$. Crystals obtained were spherical or cylindrical, of diameter about 2 cm. Faces parallel to (100), (110) and (103) were cut with a chisel or microtome. The surface imperfections were removed by electrolytic polishing. The diffuse reflections from regions of reciprocal space surrounding the reciprocal points 400, 440 and 103 were investigated using a Geiger-counter spectrometer. The results were: $c_{11} = 8.6$, $c_{33} = 13.3$, $c_{44} = 4.9$, $c_{66} = 5.3$, $c_{12} = 3.5$, $c_{13} = 3.0 \times 10^{11}$ dyne. cm.$^{-2}$, the estimated accuracy being 7%. The values for c_{33}, c_{44}, c_{66}, c_{13} differ considerably from previous values given by Bridgman. A noteworthy feature of the diffuse reflection was the background intensity. Although this did not interfere with the measurement of the elastic constants, it indicates the presence of diffuse reflection due to some other cause than that which is associated with the long acoustic waves. A.

539.373

3317. EFFECT OF TEMPERATURE ON THE FLOW STRESS OF WORK-HARDENED COPPER CRYSTALS. M.A.Adams and A.H.Cottrell.
Phil. Mag., Vol. 46, 1187-93 (Nov., 1955).

Changes in the flow stress of copper crystals due to changes in the temperature of deformation have been measured over a range of strains and temperatures. After correction for the effect of temperature on elastic constants the flow stress proves to be insensitive to temperature from 90° K to 180° K, falls rapidly with increasing temperature from 180° K to 250° K, and is virtually constant from 250° K to 473° K (the highest temperature examined). The change of flow stress with temperature is closely proportional to the flow stress itself. These results are discussed briefly in terms of recent ideas

of dislocation processes sensitive to temperature. The effect of increasing the temperature of deformation is to produce a yield drop, similar to those observed in aluminium crystals during work softening. A.

539.373

3318. THE GENERATION OF LATTICE DEFECTS BY MOVING DISLOCATIONS, AND ITS APPLICATION TO THE TEMPERATURE DEPENDENCE OF THE FLOW-STRESS OF F.C.C. CRYSTALS. A.Seeger.
Phil. Mag., Vol. 46, 1194-217 (Nov., 1955).

Treats in some detail the various mechanisms by which lattice defects are formed by moving dislocations. Particular attention is paid to the role of thermal energy in these processes and to the special features of extended dislocations in metals with low stacking fault energies. The results are applied to the temperature dependence of flow stress of such metals and are found to explain the temperature dependence observed in Cu quantitatively. Cu is known to have a low stacking fault energy. It is possible to deduce details about the mechanism of plastic deformation, in particular of the role played by the edge and the screw parts of dislocation rings under various conditions. The predictions of the theory on the nature of the lattice defects causing the increase of electrical resistance during cold work are shown to be borne out by recovery experiments. A.

539.373 : 548.7

3319. THE FORMATION OF CRACKS IN PLASTIC FLOW.II. A.N.Stroh.
Proc. Roy. Soc. A, Vol. 232, 548-60 (Nov. 22, 1955).

For Pt I, see Abstr. 6941 (1954). The detailed mechanism by which a piled-up group of dislocations generates a crack is considered; it is suggested that a crack arises from short-range non-Hookian interactions of the dislocations at the head of the pile-up, and a model which takes some account of this is developed. The possibility of relieving the stresses round the pile-up by slip in the perfect lattice instead of by fracture is considered. Finally, it is shown that a crack can equally well be initiated by a smaller number of dislocations in each of several slip planes; this may be important in ductile materials. A.

539.374

3320. EFFECTS OF TEMPERATURE ON THE PLASTIC PROPERTIES OF ALUMINIUM CRYSTALS. A.H.Cottrell and R.J.Stokes.
Proc. Roy. Soc. A, Vol. 233, 17-34 (Dec. 6, 1955).

By changing the temperature of deformation, during tensile experiments on single crystals of aluminium, it has proved possible to separate reversible changes of flow stress with temperature from irreversible ones. Below 130°K the reversible change of flow stress is large; above room temperature it is hardly more than the change of elastic constants with temperature. These reversible changes are highly reproducible and, over a wide range of cold-worked states, proportional to the flow stress itself. The principal irreversible effect is a sharp yield drop, accompanied by a Lüders band, which appears when a crystal is strained plastically at a high temperature (e.g. 300°K) immediately after being heavily cold-worked at a low temperature (e.g. 90°K). Intermediate annealing treatments reduce or eliminate this yield drop. Other experiments have proved that the yield drop is not a strain-ageing phenomenon but an extreme example of work softening, and that work hardening induced by preliminary deformation at the low temperature becomes unstable during plastic deformation at the high temperature and is rapidly removed. An explanation of the yield drop is suggested, based on recent theories of work hardening. It is proposed that, under the combined influence of stress and temperature, sessile dislocations at the heads of piled-up groups of dislocations become unlocked; the piled-up groups then partly collapse and many dislocations are released for slip. The reversible changes of flow stress are interpreted in terms of the intersection of dislocation lines. A.

539.374

3321. HYPO-ELASTICITY AND PLASTICITY. A.E.Green.
Proc. Roy. Soc. A, Vol. 234, 46-59 (Jan. 24, 1956).

A general theory of work-hardening incompressible plastic materials is developed as a special case of Truesdell's theory of hypo-elasticity. Equations are given in general coordinates for a single loading followed by one unloading, and attention is directed to materials for which the stress-logarithmic strain curve for unloading in simple extension is linear. Using a particular case of the corresponding constitutive equations for loading, which is a generalization of that suggested by Prager, applications are made to a number of specific problems. A.

539.4.01 : 532.696.1

3322. ON THE CHARACTERISTIC OF THE WEAKENING EFFECT. M.Sato.
Ark. Fys., Vol. 10, Paper 3, 37-44 (1955).

In connection with Benedicks' idea concerning the weakening effect on solid bodies due to wetting by liquids, the characteristic of this remarkable effect is duscussed, assuming that the fracture should occur by consuming the strain energy stored in Taylor's elementary prism for fracture. A.

539.4.01 : 532.696.1

3323. THE WETTING EFFECT ON QUENCHED CARBON STEEL WITHIN ITS ELASTIC LIMIT. M.Sato.
Ark. Fys., Vol. 10, Paper 4, 45-8 (1955).

The change in Young's modulus of a quenched carbon steel due to wetting by several liquids is studied experimentally. It is found that the modulus is lowered by a group of liquids, while the reverse is the case with another group. The order of magnitude of this change is the same as that observed by Benedicks in his bending tensile test. Applying the experimental data obtained in the weakening effect for determining the surface tension of the specimen, it is found that the surface tension of this steel is c.350 dyne/cm at 18-20°C which agrees fairly well with Benedicks' result of determination. A.

539.4.016.2

3324. ON THE LINEAR WORK HARDENING RATE OF FACE-CENTRED CUBIC SINGLE CRYSTALS. J.Friedel.
Phil. Mag., Vol. 46, 1169-86 (Nov., 1955).

The linear strain hardening observed after the easy glide region in face-centred cubic single crystals at sufficiently low temperature is explained by assuming that all the Frank—Read sources of the active slip system are in action, and form small active slip planes bounded on all four sides by Cottrell barriers. The initial easy glide region should occur before all the barriers are formed; the parabolic strain hardening appearing in the final stages would be related to a thermally activated breaking of the piled-up dislocations through the Cottrell barriers. A.

539.42 : 539.32

3325. AUTOMATIC BALANCE FOR MEASUREMENT OF THE STRENGTH OF GLASS FIBERS. D.Sinclair.
Rev. sci. Instrum., Vol. 27, No. 1, 34-6 (Jan., 1956).

The semiautomatic balance (Abstr. 5344/1950), used to measure the tensile strength and Young's modulus of glass fibres when bent into a loop, has been made fully automatic. A differential transformer and servomotor are used to apply chain-weight as the tension in the looped fibre is increased by the loading motor. All measurements needed to calculate the tensile strength and Young's modulus are automatically recorded on the drum chart driven by the loading motor. The maximum tensile stress in the looped fibre at the instant of break is proportional to the vertical motion of the recording pen, and the maximum strain is proportional to the rotation of the drum. A.

539.61

3326. THE ADHESION OF CLEAN METALS. F.P.Bowden

and G.W.Rowe.
Proc. Phys. Soc. A, Vol. 233, 429-42 (Jan. 10, 1956).

Describes a study of the adhesion between metallic surfaces which have been denuded of surface films by heating in a high vacuum (about 10^{-5} micron). Earlier experiments have shown that when two very soft metal specimens are pressed together they adhere strongly, but these results have in the past often been considered anomalous. The present work shows that harder metals also adhere on contact, although low values of normal adhesion are recorded after pure normal loading, even when the surfaces have been denuded. This apparent lack of adhesion is attributed to the influence of released elastic stresses, which may break many of the bridges formed between surface asperities as soon as the load is removed. If the conditions are such that the bridges can extend in a ductile manner and so accommodate the elastic recovery, the junction may retain its full strength. The measured adhesion is then equal to the original load. This is found for indium at room temperature and for other metals when the temperature is high enough to allow the bridges to anneal. When a tangential force is applied to the loaded specimens the area of contact can be increased by plastic flow under the influence of combined normal and tangential stresses, so that enhanced junction strength is obtained. Adhesion coefficients well over 10 have been measured at room temperature. A simple extension of the junction-growth theory proposed by McFarlane and Tabor for indium takes account of the influence of elastic recovery and is found to be applicable to metals generally. The close relationship between adhesion and friction is apparent. A.

539 62

3327. A USEFUL FRICTION RECORDER. P.F.Kurz.
Amer. J. Phys., Vol. 24, No. 3, 174-5 (March, 1956)

A simple apparatus for recording frictional forces and changes in such forces encountered in traversing plane surfaces is described. Typical records are presented and the flexibility of the apparatus is discussed. A

539.67

3328. VISCOSITY AND INTERNAL FRICTION IN METAL WIRES. C.Sălceanu.
C.R. Acad. Sci. (Paris), Vol. 241, No. 22, 1554-5 (Nov. 28, 1955). In French.

Derives relation between viscosity (η) of metal in solid state and logarithmic decrement (λ) as measured in determinations of internal friction by oscillations in wire specimen. Agreement is found between trend of η calc. and λ obs. as frequency of oscillation varies. It is suggested that there must be a connection between these physical constants.

J.W.Menter

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM. CHEMICAL REACTIONS 541.11/.12

541.122

3329. ENERGETICS AND STABILITY OF INTERMOLECULAR COMPLEXES IN SOLUTION. S.R.Mohanty.
J. chem. Phys., Vol. 24, No. 1, 170 (Jan., 1956).

It is suggested that the equilibrium constant of the reaction $A + B \rightleftharpoons AB + \Delta E$ cal is measured by cot $\theta/2$ where θ is the angle between the initial (diminishing excess of A) branch and the final (increasing excess of B) branch of the curve showing ΔE plotted against increasing amounts of B in a fixed amount of A. W.Good

541.123.2

3330. SHAPE OF THE COEXISTENCE CURVE IN THE PERFLUOROMETHYLCYCLOHEXANE-CARBON TETRACHLORIDE SYSTEM. R.Gopal and O.K.Rice.
J. chem. Phys., Vol. 23, No. 12, 2428-31 (Dec., 1955).

Transition temperatures for the transition from the one-phase to the two-phase condition have been observed for this syztem. It is found that $(T_C - T + 0.001^\circ)^{1/3}$ (where T_C, which is equal to 28.623°, is the observed critical temperature) is a linear function of the molecular fraction of carbon tetrachloride. As is indicated by the form of this function there appears to be a flat horizontal portion at the top of the coexistence curve, which extends from 0.5375 to 0.5625 volume fraction CCl_4. It involves such a small temperature range as to be almost unobservable and the flat top is much less marked than in the cyclohexane-aniline system. The melting point of perfluoromethylcyclohexane has been found to be −41.72° C. A.

541.123.2

3331. MASS SPECTROMETRIC STUDY OF THE $B_2D_6 - B_5H_9$ EXCHANGE REACTION. W.S.Koski, J.J.Kaufman, L.Friedman and A.P.Irsa.
J. chem. Phys., Vol. 24, No. 2, 221-5 (Feb., 1956).

The distribution of partially deuterated pentaborane species resulting from the reaction between $B_2D_6 - B_5H_9$ and its converse $B_2H_6 - B_5D_9$ has been examined mass spectroscopically. It was found that the deuterium is entering the pentaborane by two main processes; namely exchange and synthesis by pyrolysis of diborane. The number of readily exchangeable positions in the pentaborane under the experimental conditions is five. If the remaining four hydrogens are exchanging they are doing so at a very much slower rate. Examination of the mass spectrum indicates that the deuteriums are entering the molecule singly during exchange. Tracer studies with B^{10} indicate that borons are not involved in the exchange. A.

541.123.2

3332. USE OF VAPOR PRESSURE MEASUREMENTS FOR THE DETERMINATION OF PHASE EQUILIBRIUM DIAGRAMS ON CONDENSED BINARY MIXTURES. R.Heastie.
J. chem. Phys., Vol. 24, No. 2, 490-1 (Feb., 1956).

It is shown that by plotting the log of the total pressure of the mixture against 1/T the extrapolation usually needed for the determination of transition points from the plot of another property against temperature is avoided. W.Good

541.124

3333. ROLE OF WATER IN OXIDATION-REDUCTION REACTIONS. W.L.Reynolds and R.W.Lumry.
J. chem. Phys., Vol. 23, No. 12, 2460 (Dec., 1955).

Group transfer mechanisms for ferrous ion oxidation in aqueous solution are suggested, in which hydrogen ions migrate by a process reminiscent of Grothus conduction down a chain of oriented water molecules to supplement the simultaneous rearrangement of electrons in the terminal reactants and thus complete the transfer step. Four lines of evidence supporting the proposed mechanism are adduced.

R.C.Murray

541.124 : 539.167

3334. REACTIONS OF Br^{80} (18 MIN) PRODUCED BY ISOMERIC TRANSITION OF Br^{80m} (4.58 HR) WITH BENZENE AND METHYLATED BENZENES. T.A.Carlson and W.S.Koski.
J. chem. Phys., Vol. 23, No. 12, 2410-14 (Dec., 1955).

The reactions of benzene, toluene, para- and ortho-xylene, and mesitylene with Br^{80} as a result of isomeric transition have been studied. It was found that the reactions were complex. The substitution reaction was accompanied by condensation reactions. Evidence was found that organic bromides with boiling points higher than bromobenzene were formed in appreciable yields. Hydrolysis experiments indicated that both primary and secondary bromides were included in these high boiling compounds. Scavenger experiments indicated that the substitution reactions were proceeding in the main through fast bromine atom reactions. No evidence was obtained that any appreciable amounts of the substitution reactions were proceeding through a positive bromine ion mechanism. A.

541.127

3335. RATE OF REACTION OF TNT IN DETONATION BY DIRECT PRESSURE MEASUREMENTS. M.A.Cook and R.T.Keyes.
J. chem. Phys., Vol. 24, No. 2, 191-201 (Feb., 1956).

A description of an experimental method of obtaining pressure-time data for the decomposition of coarse TNT following partial detonation is given. This method consisted of photographing (with a streak camera) the displacement of a slug shot from a smooth bore cannon. The velocity and acceleration of the slug were obtained by numerical differentiation of the displacement-time data derived from the photograph. Pressure-time curves were obtained which exhibited pressure maxima at times that were dependent upon the particle size of the TNT detonated in the cannon. Peak pressures for TNT of 4-6 standard mesh particle size occurred between 140-200 microsec, peak pressures for 8-10 mesh occurred between 115-140 microsec, and pressure maxima for "fine" TNT occurred between 50-70 microsec. The pressure-time curves were analysed, and reaction times of the coarse TNT were calculated by two different methods. One method yielded a value of the reaction time for each pressure-time coordinate and the other a reaction time in terms of the time at which maximum pressure occurred. The results obtained by these two methods were not the same. However, when corrections were made for gas leakage from the cannon, rather good agreement resulted. The most probable value computed (after leakage corrections were made) for the 4-6 TNT was found to be about 300 microsec and for the 8-10 TNT about 200 microsec. On the basis of these reaction times the grain erosion velocity for the TNT in the cannon was evidently much greater than linear burning rates at the same pressure obtained experimentally for explosive deflagration. A.

541.127

3336. INFRARED STUDY OF THE B_2D_6-B_5H_9 EXCHANGE REACTION. J.J.Kaufman and W.S.Koski.
J. chem. Phys., Vol. 24, No. 2, 403-5 (Feb., 1956).

An infrared spectroscopic study of partially deuterated pentaborane samples prepared by exchanging deuterium between diborane and pentaborane has been made. A comparison of these data with corresponding mass spectroscopic measurements shows that when this exchange takes place at 80° C only the nonbridge hydrogen positions in the pentaborane are involved. A.

ELECTROCHEMISTRY 541.13

541.135

3337. A MERCURY SAFETY VALVE FOR ELECTROLYSIS OF HEAVY WATER. R.M.Chaudhri.
Proc. Phys. Soc. B, Vol. 68, Pt 12, 1157-8 (Dec., 1955).

A simple device is described for maintaining a constant pressure in the electrolysis cell while continuously taking off the heavy hydrogen during electrolysis. W.Good

541.135.3 : 539.155.2

3338. ISOTOPIC EFFECT DURING ELECTROLYTIC MIGRATION OF Li IONS IN MOLTEN LITHIUM NITRATE. A.Lunden, E.U.Monse and N.G.Sjöberg.
Z.Naturforsch., Vol. 11a, No. 1, 75-9 (1956). In German.

Electrolysis of molten $LiNO_3$ results in the increase of the proportion ratio Li^7/Li^6 near the anode. The relative difference between the rates of electrolytic migration of these ions was found to be 0.77%. The mass effect (for a probability of 95%) amounts to $\mu = -(0.050 \pm 0.013)$, which is more than the value for the mass effect found for K ions in molten KNO_3. F.Lachman

541.135.5 : 621.9.01 : 621.357.1

3339. MICROMACHINING WITH VIRTUAL ELECTRODES. A.Uhlir, Jr.
Rev. sci. Instrum., Vol. 26, No. 10, 965-8 (Oct., 1955).

Minute holes have been drilled in germanium, molybdenum, iron, copper, silver, and tungsten carbide by a new technique for machining by electrolytic etching. The flow of current is localized by a nonconducting partition in the electrolyte. The partition may be a glass tube drawn down to a tip as small as one micron dia. A variety of shapes can be produced by moving the tip with respect to the work. Holes 20 microns in dia. and 1 mm deep have been drilled; shallow grooves 2 microns wide have been made. Localized plating has also been accomplished with the technique. A.

PHOTOCHEMISTRY. RADIATION CHEMISTRY 541.14/.15

541.15

3340. HOW RADIATION CHANGES POLYMER MECHANICAL PROPERTIES. C.D.Bopp and O.Sisman.
Nucleonics, Vol. 13, No. 10, 51-5 (Oct., 1955).

The action of radiation on the deformation properties of plastics and elastomers is discussed qualitatively in terms of the effects of cross-linking and cleavage. Stress-strain curves for irradiated and unirradiated materials illustrate the difference in behaviour between polymers in which cross-linking predominates and those in which irradiation causes mainly cleavage. Polymers are grouped according to their stability to cleavage and this is explained in terms of the chemical action of free hydrogen atoms and hydrogen halides on atoms in the polymer chains. L.R.Shepherd

541.15

3341. INHIBITOR BREAKDOWN IN ZINC BROMIDE SHIELDING WINDOWS. D.T.Haworth.
Nucleonics, Vol. 13, No. 10, 66 (Oct., 1955).

Hydroxylamine hydrochloride inhibits the radiation-induced breakdown of zinc bromide. The doses required to exhaust the inhibitor and thereafter produce breakdown of the bromide were measured for different concentrations of the inhibitor. It is recommended that 3.8 to 4.5 oz of hydroxylamine per 100 gallons of zinc bromide is an economical concentration. L.R.Shepherd

541.15

3342. PROTON TRANSFER IN THE RADIATION CHEMISTRY OF GASEOUS AMMONIA. A.B.Zahlan and B.P.Burtt.
J. chem. Phys., Vol. 24, No. 2, 478 (Feb., 1956).

Results of experiments on the effects of pressure and intensity on the net ion yield in the decomposition of ammonia by alpha-particles can be explained if NH_3^+ and NH_2^+ which occur in irradiated NH_3 react with NH_3 by proton transfer to form NH_4^+. (N.B. This reverses the opinion previously held.) C.B.Allsopp

541.15 : 548.7

3343. RADIATION-INDUCED COLORING OF SODIUM

AZIDE. H.Rosenwasser, R.W.Dreyfus and P.W.Levy.
J. chem. Phys., Vol. 24, No. 2, 184-90 (Feb., 1956).

The colouring of sodium azide (NaN_3) by gamma-ray and fast and slow neutron bombardment has been studied by reflection measurements. Gamma-rays alone produce a broad absorption band at 3600 A, which is little affected by heating at 90°C, and poorly-defined bands at 6000 A and 7600 A which decay completely at room temperature. Fast neutron irradiation at room temperature, or slow neutron irradiation at 100°C, as well as slow neutron irradiation at room temperature and subsequent heating at approximately 90°C give rise to a band at 6000 A. This also appears when material, which has been subjected to gamma-ray irradiation, is heated at higher temperatures. When heated near the decomposition temperature, the spectra of NaN_3 crystals which have been subjected to any of the above forms of irradiation are similar. At this temperature another band appears at 2800 A. Heat treatment alone colours the unirradiated material primarily near 3600 A, but much less intensely than in irradiated crystals. It appears that some of the observed bands are connected with the decomposition of this compound, brought about either by irradiation or thermal treatment. A.

DISPERSIONS. COLLOIDS. ADSORPTION 541.18

541.182.4 : 532.12/.13

3344. THE EFFECT OF INTERFACIAL STABILIZING FILMS ON THE ELASTIC AND VISCOUS PROPERTIES OF EMULSIONS. J.G.Oldroyd.
Proc. Roy. Soc. A, Vol. 232, 567-77 (Nov. 22, 1955).

The investigation in a previous paper (Abstr. 7255/1953) of the elastic and viscous properties of a dilute emulsion of one incompressible viscous liquid in another, when subjected to small variable rates of strain, is extended to include the possibility of an interfacial film being present everywhere between the two components, which resists deformation as a result of internal friction or of elasticity. When the film is purely viscous its presence has no effect on the type of elastico-viscous behaviour of the emulsion, although the values of the viscosity, relaxation time and retardation time of the system are altered. When the film is ideally elastic, the viscosity in slow steady flow is the same as that of a suspension of solid particles, and two relaxation times and two retardation times are required to describe the elastico-viscous behaviour of the emulsion completely. Then the interfacial film shows more complicated elastic and viscous properties combined, these can be described by means of two operators (expressible in terms of d/dt) taking the place of elastic moduli. A viscosity operator describing the macroscopic elastic and viscous properties of the emulsion is calculated in terms of the elasticity operators of the film in the general case. A.

CHEMICAL STRUCTURE 541.2/.6

541.6 : 548.74

ROLE OF COVALENCE IN THE PEROVSKITE-TYPE MANGANITES. See Abstr. 2564

541.63 : 539 132

3345. MOLECULAR FORM OF CRYSTALLINE SYMMETRIC TETRABROMOETHANE. M.Hashimoto, T.Shimanouchi and S.Mizushima.
J. chem. Phys., Vol. 24, No. 1, 172-3 (Jan., 1956).

Infrared and Raman measurements show that both skew- and trans-forms exist in the liquid, but only the skew-form in the crystal (prepared by rapid freezing). This disagrees with Abstr. 4156 (1955). J.Hawgood

541.64 : 534.22

ULTRASONIC MEASUREMENTS ON HIGH POLYMERS. See Abstr. 1916

CHEMICAL ANALYSIS 543/545

545 82

3346. CONTINUOUS FLOW INFRARED GAS ANALYZER EMPLOYING INTERFERENCE FILTERS. J.L.Parsons, M.J.Irland and F.R.Bryan.
J. Opt. Soc. Amer., Vol. 46, No. 3, 164-6 (March, 1956).

A filter photometer for the continuous determination of a single component of a gaseous mixture is described. The instrument incorporates a combination of band pass and long wavelength pass filters of the interference type, designed to transmit in the near infrared. The analyser has been calibrated to determine hydrocarbons in automotive exhaust by means of absorbance measurements at 3.43 micron. A.

545.824

3347. ANALYSIS OF SOME INDIAN ORES AND MINERALS BY BENT MICA CRYSTAL SPECTROGRAPH.
P.K.Bhattacharyya.
Indian J. Phys., Vol. 29, No. 6, 292-5 (June, 1955).

A transmission-type bent mica crystal X-ray spectrograp has been constructed in which each wavelength chooses its own Bragg angle, and an X-ray spectrum from Fe to U could be taken in one set-up. With the help of this instrument the presence of trace elements in some Indian ores and minerals has been studied and some new results have been obtained. A

CRYSTALLOGRAPHY 548

548.4

3348. THE GEOMETRY OF LATTICE PLANES.
II. CRYSTALLOGRAPHY OF EDGE DISLOCATIONS.
M.A.Jaswon and D.B.Dove.
Acta cryst., Vol. 8, Pt 12, 806-10 (Dec., 1955).

For Pt I, see Abstr. 4176 (1955). A crystallographic procedure is given for constructing a dislocation of given Burgers vector in any crystal structure. The theory is applied to glissile dislocations in the c.p.h. and diamond structures, and to sessile dislocations in the f.c.c. and b.c.c. lattices. A.

548.51

3349. SUBLIMATION NUCLEI. S.C.Mossop.
Proc. Phys. Soc. B, Vol. 69, Pt 2, 161-4 (Feb., 1956).

The formation of ice crystals in cloud chambers generally takes place by the freezing of supercooled water drops rather than by the sublimation of vapour on to suitable nuclei. Fournie d'Albe found that particles of cadmium iodide possessed the unusual property of allowing ice crystals to grow on their surfaces by sublimation, under certain circumstances. Three other substances, $CaCO_3$, $CaSO_4.2H_2O$ and sodium bentonite

clay have now been found to behave similarly. An explanation is suggested. A.

548.51

3350. THE NUCLEATION OF SUPERCOOLED WATER BY VARIOUS CHEMICALS. S.C.Mossop.
Proc. Phys. Soc. B, Vol. 69, Pt 2, 165-74 (Feb., 1956).

A cooled expansion chamber was used to form water clouds upon aerosol particles of a variety of chemical substances of low solubility. The proportion of ice crystals to water drops in the clouds was observed at a series of decreasing temperatures. In this way the ice-forming ability of the various chemicals could be assessed. In general it was found that for the particular substances chosen, the chemicals which caused water to freeze at the highest temperatures were those in which the lattice spacing approached most closely that in the ice lattice. Some exceptions to this rule show that geometrical considerations alone are insufficient to account for nucleating ability. A.

548.52

3351. GROWTH TWINS IN GERMANIUM. G.F.Bolling, W.A.Tiller and J.W.Rutter.
Canad. J. Phys., Vol. 34, No. 3, 234-40 (March, 1956).

The occurrence of growth twins in germanium was investigated as a function of the thermal, constitutional, and crystallographic conditions of solidification; it was found to be very markedly dependent upon these growth conditions. In every case the nucleation of a twin could be traced to a condition of supercooling, either absolute or constitutional, during solidification. A new type of substructure was also observed to form under certain growth conditions. A.

548.55

3352. MELTING PATTERNS APPEARING ON SINGLE CRYSTALS OF InSb. M.F.Millea and C.T.Tomizuka.
J. appl. Phys., Vol. 27, No. 1, 96-7 (Jan., 1956).

Thin slabs with faces perpendicular to the growth axis were cut from crystals grown from the melt then polished and etched, and placed under high vacuum within a glass tube. Observations showed that melting originated at randomly scattered sites and proceeded in a definite pattern. InSb contracts on melting and a sharply edged pattern is obtained. Photographs (magnification 10 X) of the partially melted surfaces of InSb tilted 5^0 from the (100) and 12^0 from the (111) planes respectively are given. Patterns on Ge specimens were not observed. S.Weintroub.

ATOMIC AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 541.5

3353. EXPANSION PHENOMENA OF HYDROGEN BONDS. I. ISOTOPIC EXPANSION IN CRYSTALS. J.Pirenne.
Physica, Vol. 21, No. 12, 971-87 (Dec., 1955).

The Ubbelohde effect, i.e. the expansion, or contraction, of the hydrogen bonds in crystals when deuterium is substituted for hydrogen, is not yet well understood. Suggested interpretations based on a one-dimensional model, including possible resonance or anharmonicity effects seem oversimplified and unsatisfactory and the effect of temperature remains somewhat obscure. These phenomena are however easily understandable in terms of a simple three-dimensional model. The contributions of the three hydrogen frequencies to the expansion force, derived from spectroscopic data, are found to cancel each other almost completely and the thermal variation of the rocking frequency contribution accounts for the reversal of the effect observed for ice between low temperature and the melting point. Expansion forces obtained in this way for potassium dihydrogen-phosphate and ice are in good numerical agreement with those obtained from experimental isotopic expansions, determined by X-rays, and known elastic constants. Experimental data are however much too scarce and several new experiments are suggested in these fields. A.

548.7

3354. ON THE CALCULATION OF THE GROUND STATE AND THE MASS OF THE POLARON. G.Höhler.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 691-706 (Oct., 1955). In German.

In an earlier publication (Höhler, 1955) the variational method used gave no improvement over the method of Lee, Low, and Pines (1953). By the introduction of another correlation method between the shell quanta it is found that the ground state of the polaron is well described by a method discussed by Feynman (1955). The resulting energy of the ground state and the effective mass of the polaron are discussed.
C.A.Hogarth

548.7

3355. CALCULATION OF THE BOUND ENERGY LEVELS OF AN EXCITON IN A UNIAXIAL CRYSTAL. J.Barriol, S.Nikitine and M.Sieskind.
C.R. Acad. Sci. (Paris), Vol. 242, No. 6, 790-2 (Feb. 6, 1956). In French.

548.7

3356. SPIN-ECHO MODULATION DUE TO MAGNETIC DIPOLE INTERACTION BETWEEN A CLOSELY INTERACTING PAIR OF NUCLEI IN CRYSTALS. T.P.Das and S.K.Ghosh Roy.
Indian J. Phys., Vol. 29, No. 6, 272-8 (June, 1955).

It is shown that the strong interaction between a closely interacting pair of nuclei subject to resonance simultaneously produces a modulation of the spin-echo pattern for these nuclei. The derivation of information regarding the structure of the crystal from an analysis of this modulation pattern is discussed. A.

548.7

3357. DOUBLE FRANCK—CONDON PROCESSES IN PERTURBED CRYSTAL LATTICES AS MECHANISMS FOR RADIATIONLESS TRANSITIONS. H.Stumpf.
Z. Naturforsch., Vol. 10a, No. 12, 971-85 (1955). In German.

Capture of electrons in Frenkel defects in NaCl gives a non-equilibrium state and vibrational energy is transferred to the lattice. When the electron combines with a hole in the valence band another non-equilibrium state occurs and further energy is dissipated in lattice vibrations. The two processes may account for the whole of the band-to-band energy loss.
G.F.J.Garlick

548.7

3358. GENERAL OPTICAL SELECTION RULES IN PERIODIC CRYSTAL LATTICES. H.Haken and W.Schottky.
Z. Phys., Vol. 144, No. 1-3, 91-107 (1956). In German.

After a statement of previous theories the general problem of selection rules for band—band transitions of electrons in rigid lattices is first considered. This is extended to include the effect of electron interaction with lattice vibrations. From the wave functions of free electrons and holes it is possible to construct that for an "ionized" exciton and the method offers a possibility of obtaining that for normal excitons.
G.F.J.Garlick

548.7

3359. IMPURITY DIFFUSION IN CRYSTALS (MAINLY IONIC CRYSTALS WITH THE SODIUM CHLORIDE STRUCTURE). A.B.Lidiard.
Phil. Mag., Vol. 46, 1218-37 (Nov., 1955).

Elementary lattice kinetic theory is applied to the problem of impurity diffusion by the vacancy mechanism, special attention being paid to the case where there are appreciable

attractions between impurity atoms and vacancies. The approximate methods of association theory are used, impurity–vacancy pairs being treated at small distances of separation ('complexes') on a different footing from pairs at farther separations. Detailed formulae are presented for (i) the diffusion coefficient of impurities in face-centred cubic metals, for which the association model should be very good (Johnson mechanism) and (ii) the diffusion coefficient of divalent ions in polar crystals of the NaCl type. One important aspect of the results on divalent ions in polar crystals is the dependence of the diffusion coefficient D(c) on impurity concentration, c, when there is appreciable association. At low concentrations D(c) is proportional to c but at higher concentrations D increases more and more slowly finally tending to a saturation value. In the absence of appreciable association D(c) remains proportional to c at all concentrations and temperatures. The form of the results shows that experimental determinations of impurity diffusion coefficients are capable of throwing a very direct light on the conditions existing within many of the systems of interest in the field of colour centres (e.g. NaCl and KCl containing alkaline earth chlorides). A.

548.7

3360. SURFACE STUDIES OF X-RAY IRRADIATED POTASSIUM CHLORIDE CRYSTALS. W.J.Smith, W.J.Levio and R.Smoluchowski.
Phys. Rev., Vol. 101, No. 1, 37-40 (Jan. 1, 1956).

Multiple-beam interferometry has been used to investigate the surfaces of X-ray irradiated KCl crystals. Within the limits of the method there is no evidence for diffusion of vacancies or ions to or from the surface to account for the observed decrease in density. The change of density thus must be attributed to an internal mechanism, a possibility which finds tentative experimental support. A.

548.7 : 539.234

3361. V-CENTERS IN EVAPORATED ALKALI HALIDE FILMS. K.J.Teegarden.
J. chem. Phys., Vol. 24, No. 1, 161 (Jan., 1956).

By evaporation of an alkali halide and a halogen films containing V-centres are produced. Film thicknesses are 300-600 A and V-centre densities of $10^{20}/cm^3$ are achieved. G.F.J.Garlick

548.7

3362. CONFIGURATION COORDINATE CURVES FOR F-CENTERS IN ALKALI HALIDE CRYSTALS. G.A.Russell and C C.Klick.
Phys. Rev., Vol. 101, No. 5, 1473-9 (March 1, 1956).

Measurements have been made of the F-centre absorption band in KCl, KBr, KI, NaCl and LiF in the range from 4°K to 300°K. Analysis of these data shows that the important ionic vibrational frequency influencing the F-centre is considerably lower than that of the lattice, indicating that a configuration coordinate curve model may be the appropriate one to use, rather than the continuous dielectric model. Using the peak of the F-centre emission bands as determined by Botden, van Doorn and Haven, and the present absorption data, configuration coordinate curves are computed for the ground and excited state curves of F-centres in KCl, KBr, KI and NaCl. Using these curves, predictions of the emission bandwidths are found to be in agreement with experiment except for the case of KCl. The low efficiency of F-centre luminescence may be understood by applying the criterion for luminescence proposed by Dexter, Klick and Russell to these configuration coordinate curves. A.

548.7

3363. ON THE DIFFERENT CONCENTRATIONS OF F-CENTRES IN CRYSTALS OF NATURAL AND OF SYNTHETIC ROCK SALT. P.Pringsheim.
Z. Phys., Vol. 144, No. 1-3, 31-8 (1956). In German.

F-centres are formed more slowly by X-ray irradiation of rock salt than by similar irradiation of synthetic NaCl. F-centres in the natural crystals are also more resistant to thermal and optical bleaching. An explanation of these differences is offered. G.F.J.Garlick

548.72/.74

X-RAY AND ELECTRON INVESTIGATION OF MATERIALS. See also under "Structure of solids". Decimal classification 539.26/.27

548.73 : 539.26

SUMMARIZED PROCEEDINGS OF A CONFERENCE ON THE STRUCTURES AND TEXTURES OF METALS–LONDON, OCTOBER, 1954. See Abstr. 2467

548 732

3364. THE DIFFRACTION OF X-RAYS BY A CYLINDRICAL LATTICE. IV. E.J.W.Whittaker.
Acta cryst., Vol. 8, Pt 11, 726-9 (Nov., 1955).

For Pt III, see Abstr. 5744 (1955). The previous theoretical work presented in this series is extended to cover diffraction by regular circular cylindrical lattices with an oblique generating lattice, and by helical circular cylindrical lattices A

548.733

3365. A SINGLE-CRYSTAL AUTOMATIC DIFFRACTOMETER. I. W.L.Bond.
Acta cryst, Vol. 8, Pt 12, 741-6 (Dec., 1955).

An instrument has been built for recording simultaneously the integrated intensities of X-ray reflections and the corresponding crystal orientation angles and Bragg angles. The intensities are determined by a counter and integrating circuit A two-pen recorder makes a record of each level. Transcription of the data on to the plotter gives an undistorted reciprocal-lattice plot. All levels may be plotted to the same scale. A.

548.733

3366. A SINGLE-CRYSTAL AUTOMATIC DIFFRACTOMETER. II. T.S.Benedict.
Acta cryst., Vol. 8, Pt 12, 747-52 (Dec., 1955).

Describes the design and construction of the electronic recording and detecting circuits used in the single-crystal automatic X-ray diffractometer described by Bond in Pt I. Test experiments are discussed which show the operation of the instrument, using NaCl as the diffraction sample. A.

548.733

3367. AN ATTACHMENT FOR HIGH-TEMPERATURE SINGLE-CRYSTAL X-RAY WORK. L.S.Dent and H.F.W.Taylo
J. sci. Instrum., Vol. 33, No. 3, 89-91 (March, 1956).

This attachment to an X-ray goniometer permits single-crystal or powder photographs to be taken using copper radiation at up to 900°C. A cylindrical heating element of nickel foil is used, and serves also as a beta-filter. A

548.733

3368. A PRECISION HIGH-TEMPERATURE SPECIMEN CHAMBER FOR AN X-RAY DIFFRACTOMETER.
G.K.Williamson and A.Moore.
J. sci. Instrum., Vol.33, No. 3, 107-10 (March, 1956).

A high-temperature specimen chamber is described in which continuous gas circulation is employed in heating a specimen 1 in. dia. x 0.020 in. thick to a uniform and accurate known temperature. Using techniques sensitive to 0.1 deg C no temperature differences could be detected between the centre and periphery of the specimen in the range 20-200°C and the difference had a maximum value of less than 1 deg C at 600°C In practice the true temperature of the specimen can be measured throughout the range 20-650°C. Temperature fluctuations due to the control circuit never exceeded ± 0.5 deg C as meas

ıred on the specimen. The general reliability of the chamber ıas been critically examined. Slight modification to the instrument should raise the maximum attainable temperature to ıpproximately 900° C. A.

548.734.5

3369. EFFECT OF GEOMETRICAL PARAMETERS AND THE TIME-CONSTANT ON THE ACCURACY OF X-RAY DIFFRACTION MEASUREMENTS WITH A COUNTER-TUBE GONIOMETER. A.Trost.
Z. angew. Phys., Vol. 7, No. 10, 469-78 (1955). In German.

Considers the probable error due to the finite number of reflecting crystals; also the influence of specimen width, slit width, specimen height, slit height and the time-constants of the circuit and its current-indicator. A.R.Stokes

548.734.5

3370. THE USE OF SHORTER WAVELENGTHS IN X-RAY DIFFRACTION IN RELATION TO SCINTILLATION COUNTING. J.C.M.Brentano.
Acta cryst., Vol. 8, Pt 11, 659-61 (Nov., 1955).

After referring to the advantages of scintillation counting discussed in earlier papers, in particular to the high yield it offers in the Mo K range, the conditions are discussed which a crystal-counter powder goniometer must satisfy in order to be adapted to the small deflection angles encountered with short wavelengths and to be free of aberrations which depend on the individual powder specimen and setting and which therefore cannot be allowed for on general terms. Two arrangements complying with these conditions are described. A.

548.734.8 : 621.387.4

3371. X-RAY INTENSITY MEASUREMENTS WITH COUNTER TUBES. W.Parrish.
Philips tech. Rev., Vol. 17, No. 7-8, 206-21 (Jan.-Feb., 1956).

In X-ray diffractometry the measurement of X-ray intensities is achieved by counting quanta with a radiation detector such as the Geiger counter, proportional counter or scintillation counter. The counting rate is computed from the number of counts (which is subject to a statistical error) and the counting time interval. Different systems of "counting strategy" are discussed. Counting during a fixed time at every Bragg angle position of the detector will yield a relative statistical error inversely proportional to the square root of the counting rate, whereas measuring the time necessary for a fixed number of counts will make the relative statistical error independent of the counting rate. A third possibility, yielding a constant absolute error in the counting rates, is also mentioned. The recording counting-rate meter and the counting-rate computer, being part of the "Norelco" X-ray diffractometer equipment, are described as representatives of the fixed time and fixed count methods. Facilities can also be provided for the Cooke-Yarborough method, which is a compromise between both methods. For precise quantitative chemical and structural analysis, the integrated intensities of diffraction lines have to be determined. Corrections for non-linearity of the intensity measurements caused by the dead time of the detectors (counting losses) are discussed. The influence of inadequate crystallite orientation in the specimen can be eliminated by spinning the specimen in its own plane. A.

548.735

3372. A NEW METHOD FOR CALCULATING THE EFFECT OF THE COLLIMATING SYSTEM ON THE SMALL-ANGLE X-RAY SCATTERING PATTERN. P.W.Schmidt.
Acta cryst., Vol. 8, Pt 12, 772-7 (Dec., 1955).

The angular distribution of small-angle X-ray scattering, corrected for the effects of the collimating system, is expressed in terms of the pair distribution function. This formulation, which has not previously been used for determination of collimation corrections, is convenient when the slit height or scattering angle is large. When the slits are of inifinite height and negligible width, the slit-corrected functions are almost as easy to calculate as the perfect-collimation functions. Evaluation in terms of known functions is made for hollow spheres of uniform charge density, and the results are tabulated. The use of the tables for analysis of scattering data is described. A.

548.735

3373. DISTRIBUTION FUNCTIONS: APPLICATION TO DIRECT APPROACH TO STRUCTURES. E.F.Bertaut.
Acta cryst., Vol. 8, Pt 12, 823-32 (Dec., 1955). In French.

Treats the general problem of determining the most probable values of parameters $x_1, x_2, \ldots, x_n$ when experimental measurements of functions $F_k(x_1, \ldots, x_n)$ $k = 1, \ldots, m$) depending on these parameters are given. The resulting statistical method is outlined and is used as a method of direct approach to structures on the basis of the information experimentally available. The distribution function of the parameters $x_1, \ldots, x_n$ is expanded in a series of powers and products of the functions F_k. A method of linearization is applied when the F_k's are structure factors. The geometrical interpretation of the distribution function reconciles the geometrical viewpoint of Vand and Pepinsky with the analytical viewpoint of Karle and Hauptman. Other applications of the general method are worthy of mention. It can be shown directly that the distribution of structure factors is very close to the Gaussian distribution given by Wilson. An expansion is given, valid for every centrosymmetrical group, for the joint distribution function of the structure factors, which serves to determine their signs. A.

548.735.4

3374. THE DETERMINATION OF THE SIGNS OF STRUCTURE FACTORS BY OPTICAL METHODS. P.R.Pinnock and C.A.Taylor.
Acta cryst., Vol. 8, Pt 11, 687-91 (Nov., 1955).

The signs of the structure factors for a trial arrangement of atoms may be determined quickly and without calculation by means of optical-transform methods. The determination involves a comparison of two transforms — one of the unit-cell contents of the proposed arrangement and the other of an identical arrangement with an extra atom at the centre of symmetry; positive regions of the transform are enhanced by the extra atom and negative regions are diminished. Practical details of the technique as applied to a specific crystal structure are given and the reliability and certain advantages of the method are discussed. A.

548.735.4 : 621.397.9

3375. APPARATUS FOR THE ELECTRONIC PRESENTATION OF OPTICAL DIFFRACTION PATTERNS. A.W.Hanson and A.Menarry.
J. sci. Instrum., Vol. 33, No. 1, 24-7 (Jan., 1956).

Apparatus has been built for the rapid visual presentation of small, rather faint optical diffraction patterns. An image of the diffraction pattern is focused on the photomosaic of a television camera tube capable of accumulating, for a period of about ten seconds, a corresponding charge pattern. This pattern is transferred to a storage device where it remains for a relatively long time during which it can be continuously presented on a television receiver. Examples of stored diffraction patterns are given. A.

548.736.1 : 536.413

3376. THE PRECISE LATTICE CONSTANT AND THE EXPANSION COEFFICIENT OF CHROMIUM BETWEEN +10 AND +60° C. M.E.Straumanis and C.C.Weng.
Acta cryst., Vol. 8, Pt 7, 367-71 (July, 1955).

The constants of pure, sintered, electrolytic chromium were determined by the powder method over a range of +10 to +60° C, using copper radiation; and a value of 2.879 18 ± 0.000 04 kX or 2.8850 ± 0.0001 A at 20.0° C was obtained. The refraction correction of +0.000 06 is added to the constants. The error limits given include random as well as systematic errors. The precision of the determinations themselves (with systematic errors excluded) was between 1 : 200 000 and 1 : 400 000. The expansivity curve of chromium, showing a

slight break at +32.5° C, could be described by two expansion coefficients $\alpha = 7.47 \times 10^{-6}$ above, and 4.4×10^{-6} $(^{\circ}C)^{-1}$ below, the transition point. The average expansion coefficient of the samples agreed with that determined by Hidnert. A.

548.736.3

3377. THE INTERMETALLIC COMPOUNDS $MgBe_{13}$ and $CaBe_{13}$. T.W.Baker and J.Williams.
Acta cryst., Vol. 8, Pt 8, 519 (Aug., 1955).

548.736.3

3378. X-RAY STUDY OF TELLURIUM OXIDE GLASS. G.W.Brady.
J. chem. Phys., Vol. 24, No. 2, 477 (Feb., 1956).

Electron radial distribution functions are reproduced to show that the octahedral coordination scheme of TeO_2 is also found in a TeO_2—Li_2O glass. A.R.Stokes

548.736.3

3379. SHORT-RANGE ORDER COEXISTING WITH LONG-RANGE ORDER IN Cu_3Au. B.W.Roberts and G.H.Vineyard.
J. appl. Phys., Vol. 27, No. 3, 203-6 (March, 1956).

Diffuse X-ray scattering from a single crystal of Cu_3Au was observed at $T/T_c \cong 0.995$ where the long-range order parameter S equals 0.85. By annealing at low temperatures, nearly perfect order was obtained. A difference curve yields the diffuse scattering attributable to short-range order coexisting with the long-range order state of S = 0.85. Analysis of the diffuse intensity in absolute units gives values of the first three short-range order coefficients. The first coefficien is found to be close to the perfect order value: $\alpha_1 = 0.33$. Within experimental error the observed coefficients fit both the Cowley theory and a random long-range order model equally well. A.

548.736.4

3380. ON THE CHEMICAL BOND TYPE IN $AlPO_4$. R.Brill and A.P.deBretteville.
Acta cryst., Vol. 8, Pt 9, 567-70 (Sept., 1955).

548.737

3381. AN X-RAY STUDY ON BIVALENT SILVER AND COPPER NICOTINATE COMPOUNDS. D.M.Chackraburtty and B.Banerjee.
Indian J. Phys., Vol. 29, No. 7, 357-60 (July, 1955).

GEOPHYSICS 55

550.367

3382. THE COSMIC ABUNDANCES OF POTASSIUM, URANIUM AND THORIUM AND THE HEAT BALANCES OF THE EARTH, THE MOON AND MARS. H.C.Urey.
Proc. Nat. Acad. Sci. U.S.A., Vol. 41, No. 3, 127-44 (March, 1955).

Abundances of radioactive K, U and Th in representative chondritic meteorites appear to be higher by a factor of about 3.19 than in planetary bodies. Since the known thermal properties of the earth's mantle; the permanent anomaly in the shape of the moon; and the absence of a Martian core can all be accounted for on the basis of a decreased abundance for the above three elements, it is difficult to account for the present heat-balance of the earth without rejecting the hypothesis of radioactive heating in the initial stages of the melting of meteoritic matter. On the basis of the terrestrial abundances, the amount of heat available would be insufficient; but Al^{26} may have provided the additional thermal energy. Alternatively, a depletion of these radioactive nucleides in the planetary bodies considered could account for the required lower abundance values, if this occurred during their formation. D.R.Barber

550.38 : 523.7 : 538.3 : 532.51

3383. HYDROMAGNETISM. II. A REVIEW. W.M.Elsasser.
Amer. J. Phys., Vol. 24, No. 2, 85-110 (Feb., 1956).

The theoretical foundations having been given in Pt I (Abstr. 1401/1956) phenomena here reviewed are: character and magnitude of the geomagnetic secular variation, the geomagnetic westward drift, hydromagnetic interpretation of irregularities in the earth's angular velocity. Nature of fossil magnetism, magnetization of historical and prehistorical bricks and clays, of eruptive and sedimentary rocks, reversals of the earth's field in the geological past, evidence for pole migration. Exploration of solar magnetic fields, the solar convection zone, magnetic fields of sunspots, the sunspot cycle, the overall solar field, observations of magnetic stars, variable magnetic stars. Fields in the solar corona, streamers and prominences, magnetic storms and auroras, planetary fields, the galactic field, the problem of cosmic rays. A.

550.380 : 539.152.2

3384. A MEASUREMENT OF THE EARTH'S MAGNETIC FIELD BY NUCLEAR INDUCTION. G.S.Waters.
Nature (London), Vol. 176, 691 (Oct. 8, 1955).

Preliminary results of the total magnetic field near Christchurch, Hants. The apparatus consists of a robust portable nuclear magnetometer head and standard frequency-measuring equipment. Readings require only a few seconds. The protons in a sample of water are initially polarized magnetically at right angles to the earth's field and then the polarizing field switched off non-adiabatically. The residual magnetic vector is free to precess about the earth's magnetic field F, and so induces a signal voltage in the pick-up coil. The frequency f of the precession is related to the field by the relation $2\pi f = \gamma_p F$ where γ_p is the gyromagnetic ratio for the proton. R.S.Read

550.385 : 551.594.5 : 550.510.535

METEOR IONIZATION, MAGNETIC STORMS, AND THE AURORA. See Abstr. 2593

ATMOSPHERE. METEOROLOGY 551.5

551.510.535

RADIO-WAVE PROPAGATION IN THE IONOSPHERE. See also under "Electromagnetic waves and oscillations". Decimal classification 538.566.3

551.510.535

3385. INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS MIXED COMMISSION OF THE IONOSPHERE. PROCEEDINGS OF THE FOURTH MEETING, BRUSSELS, AUGUST 16-18, 1954.
Secrétariat Général de l' U.R.S.I., 42 Rue des Minimes, Brussels (1955) 238 pp.

For abstracts see Abstr. 2570-96 (1956). The remaining papers were published previously elsewhere; see Abstr. 5779, 5785, 9286 (1955).

551.510.535

3386. A NOTE ON THE WORLD-WIDE DISTRIBUTION OF THE SPORADIC E IONISATION. L.J.Prechner.
Marconi Rev., Vol. 18, 1-7 (1st Qtr, 1955).

It is suggested that there are two limiting types of sporadic E-layer, one in the high and one in the low latitudes, whilst in the intermediate latitudes both these types can occur. A.

551.510.535

3387. ELECTRONIC COLLISIONAL FREQUENCY IN THE F-REGION OVER CALCUTTA. S.Datta.
Indian J. Phys., Vol. 29, No. 6, 279-84 (June, 1955).

Results of measurements of the effective electronic collisional frequency in the F-region of the ionosphere over Calcutta (geographic latitude 22°33'; geomagnetic latitude 13° N) are described. The measurement was based upon the theoretical formula of Appleton (1935), relating the reflection coefficient of an ionospheric region with the difference between the group and optical paths within the region. The collisional frequency is found to be of the order 3.8×10^3 per sec per electron in the F-region of the ionosphere. An attempt is also made to find out the variation of the same with height in the F-region. A.

551.510.535

3388. DISTORTION OF THE E LAYER OF THE IONOSPHERE BY ELECTRICAL CURRENTS FLOWING IN IT. E.V.Appleton, A.J.Lyon and A.G.Turnbull.
Nature (London), Vol. 176, 897-9 (Nov. 12, 1955).

Determination of the recombination coefficient in the E-layer from measurements of the diurnal asymmetry of the ionization density leads to unacceptably large apparent variations. This and other anomalies can be accounted for in terms of the influence of vertical ion drift brought about by the S_q overhead current system. G.M.Brown

551.576

3389. PHYSICS OF ATMOSPHERIC CLOUDS. F.H.Ludlam.
Nature (London), Vol. 177, 320-1 (Feb. 18, 1956).

Brief report of a joint conference held by the Physical Society and the Royal Meteorological Society in London, Jan. 4-5 (1956).

551.578.1

3390. RAIN — NATURAL AND ARTIFICIAL. R.C.Sutcliffe.
Brit. J. appl. Phys., Vol. 7, No. 3, 85-88 (March, 1956).

Mean precipitation over the earth's surface is about 90 cm per year. This is balanced by evaporation using about 20% of the total solar energy incident upon the earth and its atmosphere. The world patterns of precipitation and evaporation do not coincide; balance is maintained by transport in wind systems. The mechanisms for condensing the vapour require vertical motion and adiabatic cooling by expansion: by orographic ascent, vertical (static) instability and large-scale cyclonic (dynamical) instability. Supersaturation does not occur owing to the presence of minute nuclei in vast numbers. Cloud droplets have diameters of about 10 microns and number about 200/cm^3. Raindrops have diameters about 1 mm equivalent to about 10^6 cloud droplets. The process of combination may be coalescence of droplets (warm rain) or by distillation from water droplets on to ice crystals at sub-freezing temperatures. The introduction of nuclei or ice crystals (silver iodide, common salt, solid carbon dioxide, etc.) into cloud may produce a little precipitation in special circumstances but no method of economic value is yet established. Interference with radiation, evaporation or the large-scale dynamics is conceivable but at present purely speculative. A.

551.593.5

3391. INFRARED TRANSMISSION OF SYNTHETIC ATMOSPHERES. I. INSTRUMENTATION. J.N.Howard, D.E.Burch and D.Williams.
J. Opt. Soc. Amer., Vol. 40, No. 3, 180-90 (March, 1956).

A technique for investigation of the infrared absorption of water vapour and carbon dioxide under simulated atmospheric conditions has been developed. The "total absorption" or area under the curve giving fractional absorption as a function of frequency can be determined for each spectral region in which characteristic absorption occurs. The apparatus includes a 22 m multiple-traversal absorption cell which permits controlled variation of the following parameters: (1) geometrical path length, (2) pressure of absorbing gas, (3) pressure of the nonabsorbing gases nitrogen and oxygen, and (4) the temperature of the gaseous mixture. A prism spectrometer is used to measure fractional absorption as a function of frequency under various experimental conditions. Although the observed shape of a given absorption band depends upon the effective slit widths of the spectrometer, the total absorption of a band depends, within wide limits, only on the foregoing listed parameters. For the range of temperatures encountered in the lower atmosphere, the influence of temperature variation on total absorption is so small that it can be neglected. On the basis of results obtained by the techniques described, it is possible to make accurate predictions of absorption of infrared radiation in the earth's atmosphere. A.

551.593.55

3392. DETECTION OF ATMOSPHERIC DUST AND TEMPERATURE INVERSIONS BY TWILIGHT SCATTERING. E.K.Bigg.
Nature (London), Vol. 177, 77-9 (Jan. 14, 1956).

The red and infrared light from a narrow cone in the vertical plane containing the sun and at an angle of 20° to the horizon was directed on to a photocell and amplifier system. The ratio of the rate of change of illumination to the illumination was observed as a function of time i.e. of the height of the scattering element. The curves obtained showed that there was usually a scattering maximum at about 15 km, nearly constant scattering up to 80 km and then a second maximum. The maxima were associated with temperature inversions. The observations are consistent with Bowen's rainfall-meteor dust hypothesis but are not conclusive. J.M.Hough

551.594.14 : 537.591.8

3393. COSMIC RAY PRODUCED BERYLLIUM ISOTOPES IN RAIN WATER. P.S.Goel, S.Jha, D.Lal, P.Radhakrishna and Rama.
Nuclear Physics, Vol. 1, No. 3, 196-201 (1956).

The two known radioactive isotopes of beryllium (Be^7 and Be^{10}) are produced in the atmosphere in nuclear disintegrations initiated by cosmic radiation. The long lived Be^{10} (half-life 2.7 million years) is difficult to detect and has not yet been isolated. The short lived isotope Be^7 (half-life 53 days) is easily detected in rain water and should, therefore, be of interest in meteorological studies. The average concentration of Be^7 in 8 monsoon rains in Bombay amounted to 2400 atoms per cm^3 and is consistent with the production rates predicted by Peters (Abstr. 5798/1955). A.

551.594.21

3394. HAIL GROWTH AS A SOURCE OF THE THUNDERSTORM ELECTRICITY. F.Wolf.
Naturwissenschaften, Vol. 42, No. 24, 641-2 (1955). In German.

Attention is drawn to the Faraday—Sohncke effect according to which a water drop impinging on, and dispersed by an ice particle assumes a negative charge while the ice particle retains positive charge. It is suggested that a combination of this effect with the growth, fall and rise of hail particles (Abstr. 9861/1951) explains the generation and distribution of the thundercloud charges and that it is sufficient to account for the lightning activity in a moderate storm. R.H.Golde

551.594.5

3395. THE POLAR AURORA. C.Størmer.
London: Oxford University Press (1955), 456 pp.

Professor Størmer brings together the results of over

half a century's research, dealing with both the mathematical and observational aspects of the subject.

551.594.5 : 550.385 : 550.510.535

METEOR IONIZATION, MAGNETIC STORMS, AND THE AURORA. See Abstr. 2593

551.594.6

3396. OBSERVATIONS OF WHISTLING ATMOSPHERICS AT GEOMAGNETICALLY CONJUGATE POINTS. M.G.Morgan and H.E.Dinger; M.G.Morgan and G.McK.Allcock.
Nature (London), Vol. 177, 29-30, 30-1 (Jan. 7, 1956).

Whistlers were observed to occur simultaneously at 55.1° and 50.2° geomagnetic latitude on the east coast of N.America, but the stronger whistler did not always occur at the same station. Tape recordings of them were analysed on a comb-filter type of sound spectrograph. Typical examples are shown. Storey's form of the frequency-dependence formula given by Eckersley, $f = (D/t)^2$, fits the data for a dispersion D = 200 where t is measured from the initiating atmospheric. The observed dispersion depends apparently upon the latitude of the storm source. It is concluded that the ability to hear a whistler depends upon the proximity of the observer to the location, or the geomagnetic conjugate location, of the atmospheric generating it. Atmospherics which produce whistlers have a characteristic sound and are called "banks". The "whistler" is a descending tone while a "swish" is a descending frequency band of noise. Further observations near geomagnetic conjugate points at about 50° geomagnetic latitude in the Aleutian Islands and New Zealand appear to confirm Storey's theory that the long dispersive paths needed by Eckersley to explain the generation of "whistlers" and "swishes" from atmospherics are along the geomagnetic flux lines between the northern and southern hemispheres. The results permit the planning of a synoptic programme of observation during the coming International Geophysical Year.
R.S.Read

BIOLOGY 57/59

578.087.9

3397. CANTILEVER PNEUMOGRAPH. W.J.Whalen and R.L.DeHaan.
Rev. sci. Instrum., Vol. 26, No. 11, 1072-5 (Nov., 1955).

A simple device utilizing a resistance wire strain gauge for the recording of respiratory movements is described. Changes in chest and diaphragmatic tone may be recorded in spite of the variations in ambient temperature which markedly affect conventional bellows-type pneumographs. Greater sensitivity is obtained and leaks in the system are not a problem. The frequency response is well above the respiratory rate of panting animals. Finally, the cost is minimal. A.

MEDICAL SCIENCE. HUMAN PHYSIOLOGY 61

612.014.47 : 534.321.9

3398. ULTRASONIC IRRADIATION OF THE CENTRAL NERVOUS SYSTEM AT HIGH SOUND LEVELS. W.J.Fry and F.Dunn.
J. Acoust. Soc. Amer., Vol. 28, No. 1, 129-31 (Jan., 1956).

High-level ultrasound produces, under properly controlled dosage conditions, selective changes in the central nervous system. The physical mechanism of the action of the sound requires elucidation. Some of the problems associated with determining the physical mechanism are discussed and a preparation and procedure are described which are appropriate for accurately determining dosage relations for such a study. The quantitative results obtained with this preparation are presented. A.

612.79 : 535.39

3399. SPECTRAL REFLECTANCE OF THE SKIN OF RATS AND RABBITS IN THE REGION 420-1000 mμ. J.M.Dimitroff, J.A.Jacquez and H.F.Kuppenheim.
J. appl. Physiol., Vol. 8, No. 3, 292-6 (Nov., 1955).

Reflectance curves of the rat, white rabbit and Caucasian human skin were obtained with the GE recording spectrophotometer; they are shaped similarly and show the prominent absorption bands of haemoglobin and water. Chinchilla rabbits were found unsuitable for such studies because of the irregular spotty distribution of pigment in their skin. Similarity, even equality of the reflectance of different species, however, does not imply similarity or equality of relative absorption in the different layers and components of the skin. The importance of the skin structure, especially the density of hair follicles, for the scattering is discussed. Reflectance data such as these furnish information for judging burn experiments on the basis of absorbed rather than incident energy. A.

612.79 : 535.39

3400. SPECTRAL REFLECTANCE OF HUMAN SKIN IN THE REGION 0.7-2.6μ. J.A.Jacquez, J.Huss, W.McKeehan, J.M.Dimitroff and H.F.Kuppenheim.
J. appl. Physiol., Vol. 8, No. 3, 297-9 (Nov., 1955).

The reflectance curves were obtained with a special recording spectrophotometer improved with a comparison type integrating sphere (see Abstr. 5964/1955) on Caucasians, negroes and Japanese. Striking differences correlated with differences in skin pigmentation appear only below 1μ. Above 1.2μ all curves are practically identical and show primarily the absorption spectrum of water; the reflectance is that of a scattering component mixed with water. The 5-6% reflectance above 2μ may represent Fresnel reflection at the skin surface. A.

612.843.2

3401. EFFECT OF STIMULUS DURATION ON ELECTRICAL RESPONSES OF THE HUMAN RETINA. E.P.Johnson and N.R.Bartlett.
J. Opt. Soc. Amer., Vol. 46, No. 3, 167-70 (March, 1956).

The size and form of the b-wave of the human electroretinogram are shown to be dependent on the duration as well as on the intensity (the term stimulus intensity refers to luminance specified in ft-L.) of the stimulating light. In determining the amplitude of submaximal b-waves, intensity and duration share equally until a certain critical duration is reached. Above this critical duration of about 100 msec in the dark-adapted eye, less under conditions of light-adaptation amplitude is determined by intensity alone. The latency of the response, however, is determined without reference to the stimulus duration. It is interesting to note that a critical duration of just over 100 msec has also been reported from psychophysical studies of the dark-adapted eye in which visual threshold rather than electrical response criteria were used. A

612.843.31

3402. A PHOTOCHEMICAL REACTION IN THE HUMAN RETINA. G.S.Brindley.

Proc. Phys. Soc. B, Vol. 68, Pt 11, 862-70 (Nov., 1955).

The way in which the disturbance of a colour match by adaptation is affected by the brightness of the adapting field is investigated. It is inferred from the results that the disturbance is due to a photochemical reaction in a pigment for which the apparent value of the product of quantum efficiency and molar decadic extinction coefficient at wavelength 0.574 micron is about 420 000. Reasons are given for believing that the true value is probably lower. Three hypotheses concerning the nature of the pigment are discussed, and it is concluded that the most likely of them is that it is the receptor pigment of the "red-receptive" mechanism of trichromatic theory. If so, this must have the very high optical density in the receptors of about 0.98. A.

612.843.31

3403. RAPID CHROMATIC ADAPTATION AND THE SENSITIVITY FUNCTIONS OF HUMAN COLOR VISION. R.M.Boynton.

J. Opt. Soc. Amer., Vol. 46, No. 3, 172-9 (March, 1956).

Previous studies have shown that the spectral sensitivity curve of the cones, in the dark-adapted eye, displays three maxima and that these are indicated even more clearly when the foveal test stimuli are superimposed upon coloured adapting stimuli. These maxima are believed to be the result of at least three underlying sensitivity functions related to the "fundamental response curves" of human colour vision. By delivering foveal, monochromatic test flashes only 0.05 sec after the onset of coloured adapting stimuli, these maxima are further enhanced and very large distortions of the usual spectral sensitivity curve result. On the assumption that the overall sensitivity curves for five conditions of adaptation are the sum of four underlying sensitivity curves (with maxima at approximately 430, 530, 570, and 610 m-micron), a satisfactory fit of the experimental data is obtained which appears to support a four-component theory of colour vision. A.

612.843.35

3404. SPATIAL EFFECTS IN FOVEAL BRIGHTNESS DISCRIMINATION. H.W.Hake and E.Averbach.

J. Opt. Soc. Amer., Vol. 46, No. 4, 274-7 (April, 1956).

Differential sensitivity for luminance differences existing in two spatially separated homogeneous fields was measured under three viewing conditions. In the first the comparison fields were separated by darkness; in the second the fields were joined by a transition area in which luminance increased linearly from the value presented in the darker field to that presented in the lighter field. A third condition controlled for the decrease in size of the fields which occurred with increasing separation. In all viewing conditions the darker field was presented to the left and to the right of the lighter field equally often; and the observer's task was to detect the darker side of the display. Detection was significantly better with the gradient present than with the fields separated by darkness. The results are discussed in terms of the suggested ability of the visual system to utilize the distribution of light in an intervening gradient to emphasize the difference in the luminances of separated fields. A.

612.843.611

3405. EFFECT OF HUE DURATIONS ON ADAPTATION TO DARKNESS. D.M.Polinsky and F.A.Young.

J. Opt. Soc. Amer., Vol. 46, No. 2, 118-21 (Feb., 1956).

The effects of hue and of different durations of exposure to hue on the course of dark adaptation were determined by having ten males wear goggles which contained either red, green, or blue filters. All subjects were exposed for durations of 2, 3.5, 5 and 10 minutes to a randomly selected hue before similar exposures to the other hues. The lengths of time required to see 15 predetermined luminance levels in a Hecht-type Adaptometer were recorded after each exposure. A trend analysis of the resulting dark adaptation curves indicated that only the curves following exposure to blue are parallel. All the curves are significantly different between adaptation levels. Blue has the least effect on dark adaptation, with red having the most and green falling between the two, but about the same as red in effectiveness at the lowest luminance values. Exposure to either red or green for three and a half to five minutes is the most effective duration for dark adaptation to the lowest luminance values. The dark adaptation curves following exposure to red have steeper slopes but level off and reach the lowest luminance values in the same time as the curves following exposure to green. A.

612.843.63

3406. DISTRIBUTION OF SENSORY UNITS IN THE EXTRAFOVEA. J.Oliva and M.Aguilar.

Optica Acta, Vol. 3, No. 1, 36-9 (March, 1956). In French.

A study is made of the circular symmetry of visual acuity of the extrafoveal retina (up to 28° from the fovea), which is closely allied to the distribution of sensory units in the retina. The results obtained show this symmetry exists, and that there is an increase in the size of sensory units and a reduction of visual acuity as the distance from the fovea increases. A.

612.843.72

3407. QUALITATIVE DEPTH LOCALIZATION WITH DIPLOPIC IMAGES. G.Westheimer and I.J.Tanzman.

J. Opt. Soc. Amer., Vol. 46, No. 2, 116-17 (Feb., 1956).

Momentary presentation of point targets seen in diplopia were made to six observers using a method of constant stimuli. Fifty presentations were given in a random order at each of 20 levels of binocular disparity from 10° crossed disparity to 10° uncrossed disparity. Thirty-four correct responses out of 50 stimulus presentations constitute the 1% significance level beyond which guessing may be ruled out. Almost all observers were able to respond considerably better than this at disparities up to about 7°, while one highly trained observer showed 90% correct responses or better up to 10° disparity. The average observer was never able to make correct responses to all presentations at any disparity used, and stimuli presented with uncrossed disparity were localized correctly more often than those with crossed disparity. A.

612.843.72

3408. EFFECT OF BINOCULAR MAGNIFICATION DEVICES ON STEREOSCOPIC DEPTH RESOLUTION. G.Westheimer.

J. Opt. Soc. Amer., Vol. 46, No. 4, 278-80 (April, 1956).

An observer's just discriminable difference in depth is a function of his interocular distance, his threshold difference in binocular parallax and the observation distance. Magnification devices consisting of lenses and/or prisms will change the threshold of depth resolution because the latter now depends on the optical properties of the device as well as on the observer's characteristics. An equation has been derived expressing this change in linear threshold of depth resolution as a function of the lens and prism power of the device, the separation of the components of the device from the eye, the observer's interocular distance and the object distance. Free choice of the optical properties of such magnifiers is, however, restricted since these properties must permit a clear retinal image of the object to be formed simultaneously on the foveas of both of the observer's eyes. In general, plus lenses and base-in prisms will enhance the depth resolution and this points to the use of such devices in tasks demanding high depth resolution at close observation distances, as, for example, in surgery or inspection of surface defects. An experimental determination of the change in linear depth resolution produced by a binocular magnifier showed close agreement with the theoretical prediction. A.

612.843.721

3409. EFFECTS OF TARGET SEPARATION AND DISTANCE ON COMMONPLACE BINOCULAR DEPTH DISCRIM-

INATION. W.H.Teichner, J.L.Kobrick and E.R.Dusek.
J. Opt. Soc. Amer., Vol. 46, No. 2, 122-5 (Feb., 1956).

Two experiments were performed to determine the effects of lateral target separation on commonplace binocular depth perception and to extend previous studies of the effects of distance to the range of 10 to 100 feet. Separations of 1.4 to 114.6 minutes were not found to have a differential effect except at the greater distances. This is attributed to a loss of visual rather than depth acuity. The effects of viewing distance were found to be consistent with previous studies of the distance effect. Differences in the effects of distance were found between sophisticated and unsophisticated subjects; the former tended to make finer discriminations especially at the greater distances. A.

612.843.721

3410. EFFECT OF FIELD SIZE AND LUMINANCE ON THE BINOCULAR SUMMATION OF SUPRATHRESHOLD STIMULI. H.Leibowitz and L.Walker.
J. Opt. Soc. Amer., Vol. 46, No. 3, 171-2 (March, 1956).

The magnitude of suprathreshold binocular brightness summation was determined as a function of field size at two levels of luminance. Luminance was not significant but the magnitude of the summation effect varied from 4% to 16% depending upon the size of the field. A.

612.843.721

3411. STEREOSCOPIC ACUITY AND THE ROLE OF CONVERGENCE. K.N.Ogle.
J. Opt. Soc. Amer., Vol. 46, No. 4, 269-73 (April, 1956).

To what extent changes in convergence can contribute to stereoscopic acuity is again considered, using new data. Certain difficulties of obtaining the most desirable measurements of stereoscopic thresholds without and with eye movements are pointed out. Data obtained by the author and by others can be interpreted to show that, physiologically, convergence changes themselves do not contribute to stereoscopic acuity over that due to disparity between the images alone. In the tests where eye movements occur, lower apparent thresolds are found because retinal regions of higher visual acuity and higher stereoacuity come into play. A.

612.844.23

3412. SPHERICAL ABERRATION OF THE EYE. G.Westheimer.
Optica Acta, Vol. 2, No. 3, 151-52 (Oct., 1955).

Ivanoff's data (Abstr. 2738/1947) are re-interpreted. R.A.Weale

612.846

3413. VISUAL EXPERIMENTS WITH A VIBRATING TEST OBJECT. A.M.Ercoles, A.Fiorentini and G.Toraldo di Francia.
Optica Acta, Vol. 3, No. 1, 40-6 (March, 1956).

In order to study the influence of eye movements on vision, detection and resolution have been measured with a vibrating test object. The experimental data obtained by three observers have been plotted both against frequency and amplitude of the vibration. It seems possible to conclude that eye movements, even of a very high frequency, have a role in affecting vision of moving objects. A.

612.85 : 591.185.5

3414. FUNCTIONAL ROLE OF THE GIANT TYMPANIC BULLAE OF CERTAIN RODENTS (MERIONES). J.P.Legouix and A.Wisner.
Acustica, Vol. 5, No. 4, 207-16 (1955). In French.

Some mammalian species, particularly rodents from desert regions, present hypertrophied bullae. This feature may be related to their acoustical properties. The amplitude of the microphonic potential is much larger for frequencies around the resonance of the middle ear even for high intensiti The response curve has the shape of a resonance curve. This suggests a low damping of the oscillatory system constituted by the middle ear structures. The anatomical study seems to agree with a damping by reactance. The organ of Corti posses ses supporting cells of large size which probably bear some relation to large displacements. A

612.8

3415. THE VARIATIONS OF BONE CONDUCTION AS A FUNCTION OF THE PRESSURE EXERTED ON THE VIBRATO E.König.
Acustica, Vol. 5, No. 4, 234-43 (1955). In French.

The intensity change of sound produced by pressing a tuning-fork or a bone-conduction receiver against the head i a well known phenomenon. After having presented a review o the criticism made by otologists and audiologists, the theory of the mechanism of bone conduction and the results of meas urements published by different authors are summarized in this paper. Finally, the effects of varying the force with whi the knob of the vibrator is pressed against the forehead are reported for three well known types of bone-conduction receivers. According to the receivers and to the frequency, varying the force of application by as much as 250 to 1500 g may cause a change of 15 or 20 dB in the determination of bone-conduction acuity.

612.858.7

3416. SENSITIVITY TO CHANGES IN THE INTERRUPTIO RATE OF WHITE NOISE. G.H.Mowbray, J.W.Gebhard and C.L.Byham.
J. Acoust. Soc. Amer., Vol. 28, No. 1, 106-10 (Jan., 1956).

Difference-limens for the discrimination of intermittenc were obtained at ten interruption rates of random noise betw 1 and 320 c/s. The duty cycle of the intermittent noise was 0.5 and the sound pressure level was 75 db. Data from four listeners give average deviations from the standard frequenc (ΔF) of 0.02 to 9.74 c/s. The graph relating ΔF and F fro 1 to 320 c/s shows ΔF to be a monotonically increasing functi of F. When the data are plotted with logarithmic coordinate two functions are revealed, suggesting a change in the metho of frequency discrimination at about 5 c/s. This change appears due to the listener's ability to count the noise bursts from 1 to 5 c/s, but not above 5 c/s. The relationship betw 5 and 320 c/s may be described by a parabolic function of the form $y = ax^b$. Below 5 c/s, the form of the relationship can not be determined from the data available. The relative difference-limen, $\Delta F/F$, lies between 0.008 and 0.03, and gra ic integration of $1/\Delta F$ yields 560 just noticeable differences the range studied. These data show difference-limens for flutter that are smaller than those previously reported. A

614.8

3417. A PERSONAL γ-RADIATION MONITOR WITH AUDIBLE WARNING DEVICE. D.Allenden and I.W.Collip.
J. sci. Instrum., Vol. 33, No. 3, 120-2 (March, 1956).

A prototype personal γ-radiation monitor is described, which uses an electrometer valve and transistor alarm circ to give an audible warning to the wearer on receipt of a tole ance dose of γ-radiation. The insulation requirements of the valve and chamber circuits and the design of the alarm circuits are discussed, particular attention being paid to ease of checking and "fail-safe" features. It is concluded that the desired performance is consistently realizable in the design presented, a dosage accuracy of the order of $\pm 5\%$ being achieved.

TECHNIQUE. MATERIALS 62/69

66.022

418. GYRO BALL-MILL. B.Claus.
. angew. Phys., Vol. 7, No. 12, 557-9 (1955). In German.

The construction of a new form in which gravity, centrigal and Coriolis forces act on the material to be milled is escribed and shown schematically. Tests, some results of hich are illustrated, indicate that improved milling speed, reater degree of fineness and uniformity of the milled subtance, are obtainable, and the better performance than that f normal ball mills is attributed to the much larger number f collisions between the particles. S.Weintroub

66.041 : 621.365.5

419. A LABORATORY SCALE CHILL-CASTING VACUUM NDUCTION FURNACE. D.A.Craw and W.G.Henry.
. sci. Instrum., Vol. 33, No. 1, 22-3 (Jan., 1956).

The details of the construction and operation of a simple aboratory scale induction furnace with a capacity of approxiately 3 cm^3, which may be used at either low pressures (10^{-4} m of mercury) or with an inert atmosphere is described. The rnace and induction unit are fitted to a tilting frame allowing e melt to be cast into a copper mould. Copper, silver, gold, agnesium and cadmium based alloys have been cast successlly with this apparatus. A.

669.783

3420. ZONE-MELTING. W.G.Pfann and K.M.Olsen.
Bell Lab. Record, Vol. 33, No. 6, 201-5 (June, 1955).

Discusses the use of zone refining to remove impurities rom germanium and the use of zone levelling to produce ighly uniform single crystals. Other variations of zone melting are mentioned briefly. W.Bardsley

PHOTOGRAPHY 77

771.35

3421. THE EFFECT OF STOPPING DOWN A PHOTOGRAPHIC OBJECTIVE WITH ABERRATIONS. F.I.Havliček.
Optik, Vol. 13, No. 1, 3-4 (1956). In German.

A photographic lens at full aperture will possess considerable amounts of residual aberrations. By stopping down, the image may be brought within the Rayleigh limit. Methods of determining the aperture at which this occurs and the position of the optimum focal plane at full aperture are described briefly. R.W.Fish

771.5 : 778.34

3422. ON DIFFERENT METHODS OF PREPARING EMULSIONS SENSITIVE TO CHARGED PARTICLES. F.Simon.
C.R. Acad. Sci. (Paris), Vol. 241, No. 22, 1564-7 (Nov. 28, 1955). In French.

Various methods of preparing sensitive emulsions have been studied and compared. A new practical method for producing emulsions with fine grains is proposed. The influence of different physical factors are examined. D.J.Prowse

771.53 : 537.531

3423. ON THE MECHANISM OF THE PHOTOGRAPHIC ACTION OF X-RAYS. I.Malinovski.
Izv. Bulg. Akad. Nauk., Vol. 4, 167-202 (1954; publ. 1955). In Bulgarian with summary (2 pp.) in English.

To investigate the influence of (light-) sensitivity specks on photographic emulsions on their X-ray sensitivity, it was required to determine the mean X-ray energy e_0 which a silver halide grain must absorb to become developable. There has hitherto been doubt as to the interpretation of the exponential constant k in the theoretical equation for the X-ray characteristic curve of the emulsion. While k should be proportional to the mean mass of the grains m, by experiment it is proportional to $m^{2/3}$. The present work has shown that this disagreement can be resolved by the fact that the number of grains developable after absorption of an X-ray quantum depends on their size and is approximately proportional to $m^{-1/3}$. If it is assumed that the photographic action depends on electrons released by X-ray absorption, e_0 appears as an empirical constant in the equation and can be determined from sensitometric data. Seven emulsions of varied light sensitivity were tested, but e_0 varied only between 1200 and 3500 eV, though larger for coarser emulsions. This dependence was explained by considering the proportion of the absorbed energy which produces undevelopable latent image within the grains. The proportion will increase for coarser emulsions and thus e_0 will increase. It was found that $e_0 m^{-1/3}$ was nearly constant. S.T.Henderson

771.535

3424. REMARKS ON THE CRITICAL TIME PERIOD AND THE SCHWARZSCHILD EXPONENT IN PHOTOGRAPHIC PROCESSES. J.Stock.
J. Opt. Soc. Amer., Vol. 46, No. 1, 17-21 (Jan., 1956).

The formation of a stable sublatent image as a result of the action of pairs of light quanta has been investigated theoretically on the basis of transitions from a ground stage through an unstable level to a higher level. Expressions for the fraction of grains in the sublatent image stage for continuous as well as for intermittent exposures have been derived, the latter for the purpose of determining the critical time period. The possibility that the absorption of more light quanta is necessary for the formation of a developable image has been taken into account. A model including low and high intensity reciprocity failure is outlined briefly. A.

778.33

3425. CONCERNING TECHNICAL EXPOSURE PROBLEMS WITH SCREENS FOR SIMULTANEOUS LAYER PROCESSES AND IMPROVEMENTS TOWARDS THEIR ATTAINMENT. J.F.Hartmann.
Naturwissenschaften, Vol. 42, No. 22, 603 (1955). In German.

The use of simultaneous-layer radiographic techniques has been restricted partly because of lack of technical information on screens and conditions used. Problems concerning filtration and intensification of screens are discussed and requirements of screens for optimum results are listed. D.V.Mabbs

778.34

3426. OBSERVATIONS OF NUCLEAR EMULSIONS IN REFLECTED LIGHT. R.Rechenmann.
Nuovo Cimento (Ser. 10), Vol. 2, No. 5, 1104-6 (Nov., 1955). In French.

A method of pouring nuclear emulsion on to opaque supports for observation in reflected light is described. The technique has been used to study the radioactivity of granite from Monte Capanne. After developing the emulsions were examined on a modified Leitz Ortholux microscope. The α-particles emitted by the mineral were then counted. D.J.Prowse

778.33

3427. SCINTILLATOR GRID LOCALIZES GAMMA EMITTERS PHOTOGRAPHICALLY. C.Kellershohn and P.Pellerin.
Nucleonics, Vol. 13, No. 12, 34-7 (Dec., 1955).

NaI scintillators are used to intensify the image produced on a photographic plate by gamma-ray sources. The crystals are set in a large number of narrow collimating channels forming a rectangular grid in a lead plate. This arrangement enables one to record an outline of the shape of the gamma-ray source which appears as a pattern of dots on the exposed plate.
L.R.Shepherd

778.33

3428. CAESIUM 137 FOR INDUSTRIAL RADIOGRAPHY. R.S.Morgan.
Brit. J. appl. Phys., Vol. 7, No. 1, 25-8 (Jan., 1956).

The suitability of caesium 137 as a γ-ray emitter for the radiography of steel has been investigated. An exposure chart has been produced and penetrameter-sensitivities calculated from experimentally determined broad-beam and narrow-beam absorption curves. The broad-beam curve is approximately linear for steel thicknesses exceeding 0.8 in., and from its slope, it would be expected that caesium 137 would give radiographs similar in contrast to an X-ray tube operating at about 1.25 million volts peak. While caesium 137 is a useful source for the examination of steel in the thickness range 1.5 to 4.0 in., below 1.5 in. iridium 192 is superior. Within the range 1.5 to 3.0 in. the penetrameter sensitivity obtainable with caesium 137 reaches its optimum value and is better than that obtainable with either iridium 192 or cobalt 60. Protection data for sources of various strengths have been calculated from an experimentally determined attenuation-curve for lead.
A.

778.33 : 535.826

3429. THE PREPARATION OF THIN BONE SECTIONS. S.M.Clark and J.Iball.
J. sci. Instrum., Vol. 32, No. 9, 366-7 (Sept., 1955).

It is pointed out that by using resin-bonded carborundum cutting wheels of 0.005 inch thickness much less material is lost than if the milling cutters (0.020 inch thick) described by Jowsey (Abstr. 6671/1955) are used. In addition, it is possible to cut thinner sections with the former. Mention is also made of a cold-setting polyester for embedding specimens which has been found particularly suitable when cutting bone sections.
J.Iball

778.34

3430. TAKING ACCOUNT OF THE FINITE THICKNESS OF THE LAYER OF EMULSION IN THE INVESTIGATION OF NUCLEAR PROCESSES BY THE AID OF THE PHOTOGRAPHIC METHOD. M.M.Agrest.
Zh. éksper. teor. Fiz., Vol. 29, No. 2 (8), 249-51 (1955).
In Russian.

A previous work (Abstr. 9338/1955) in which the ratio of the number of secondary tracks wholly in the emulsion to the total number of secondary tracks was calculated, is generalized to take account of the finite thickness of emulsion.
G.E.Brow

778.3

3431. GAP DENSITY MEASUREMENTS IN NUCLEAR EMULSIONS. F.T.Gardner and R.D.Hill.
Nuovo Cimento (Ser. 10), Vol. 2, No. 4, 820-3 (Oct., 1955).

The technique of gap counting has been extended by using measurements of the variation of the number of gaps with range. This extension is particularly useful in heavily developed G5 emulsions.
A

778.3

3432. THE VARIATION OF TRACK LENGTH WITH ANGL OF DIP IN PHOTOGRAPHIC NUCLEAR RESEARCH EMULSION. R.B.J.Palmer and H.A.B.Simons.
Proc. Phys. Soc. A, Vol. 68, Pt 10, 852-6 (Oct., 1955).

Alpha particle and $\alpha + H^3$ tracks have been measured at angles of dip between 0 and 90^0 in Ilford C2 emulsions. No significant variation in track length with angle of dip has bee found except in measurements made with one microscope. A fault in the depth measuring mechanism is shown to account for this effect.
A

778.3

3433. CRITERIA FOR THE CONSISTENT COUNTING OF DELTA RAYS ON HEAVY NUCLEAR TRACKS IN EMULSION PLATES. O.B.Young and W.C.Ballowe.
Amer. J. Phys., Vol. 24, No. 3, 157-9 (March , 1956).

An attempt to improve greatly the consistency of delta-ray counting along tracks of heavy nuclei in emulsions. The problem is complicated and, unless satisfactory criteria are properly followed, variable results may be expected both fro a given scanner and from different scanners. A set of criteri are given. Considerable information regarding their use is in cluded. This work is adapted to nuclei with Z's of ten or greater.
A

778.37 : 621.387

3434. ELECTRONIC FLASH PHOTOGRAPHY. A.S.Cross and G.F.C.Selby-Lowndes.
Brit. Commun. and Electronics, Vol. 2, No. 12, 75-8 (Dec. 1955).

The principles involved in the use of the short-duration, high-energy flash from a gaseous discharge for high-speed photography, together with a number of special applications, are described. The spectrum emitted can be easily matched to that of daylight and enable colour materials to be used. A table giving details of 18 commercial equipments of portable and studio design is included.
G.Howell